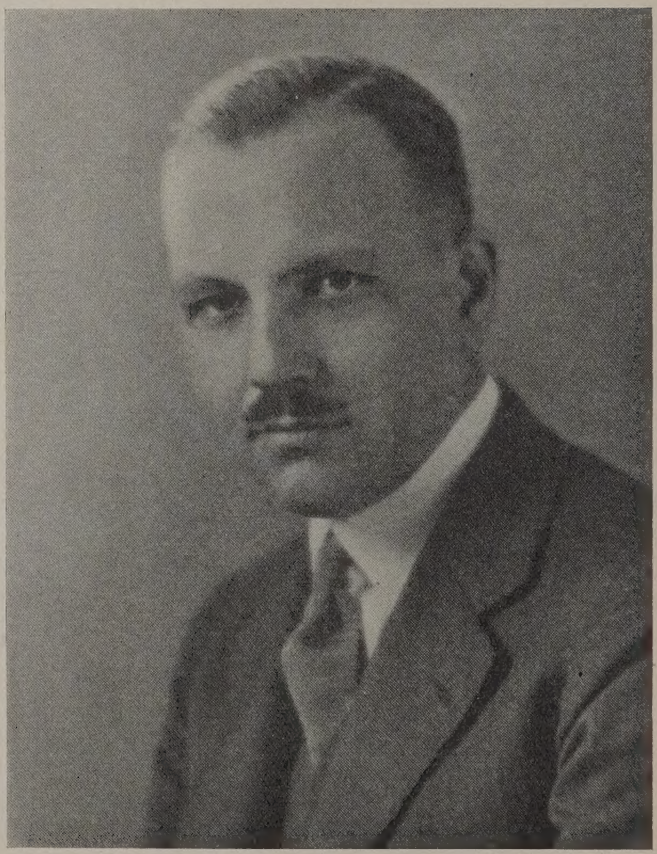

Francis Metcalf Root (1889–1934)

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FRANCIS METCALF ROOT

ROBERT HEGNER

The death of Dr. Francis Metcalf Root on October 21, 1934, at the early age of forty-five has deprived parasitology of one of its most valuable disciples. Medical Entomology, the field in which he specialized, is not as well represented among parasitologists as are Protozoology and Helminthology and we can ill afford to lose one who has played such an important part in the maintenance and advance of knowledge in this subject.

Dr. Root was born in Oberlin, Ohio, on September 24, 1889. In 1911 he was granted the A.B. degree by Oberlin College, and in 1912, the A.M. degree. His advanced work was done in the Department of Zoology at Hopkins, where he published studies on Amoeba with Dr. S. O. Mast and carried on his investigations for the Ph.D. degree under the direction of Dr. H. S. Jennings. His dissertation was devoted to a study of inheritance in the free-living protozoon, *Centropyxis aculeata.* During the war Dr. Root was Captain and Commandant in the S. A. T. C. at Oberlin.

At the time of his death, Dr. Root was Associate Professor in charge of the department of Medical Entomology in the Johns Hopkins School of Hygiene and Public Health. He was Managing Editor of the *American Journal of Hygiene,* a member of the Editorial Committee of the JOURNAL OF PARASITOLOGY and Associate Editor of *Animal Parasitology for Biological Abstracts.* Dr. Root organized and directed the work in Medical Entomology at Hopkins from the time the School of Hygiene was established until his death. He took part in the various activities of the School and could always be depended upon to fulfill his obligations with distinction and dispatch. He was one of the best lecturers in the School, and presented the results of his researches before the Research Club and Scientific Societies in admirable fashion.

Dr. Root's early training was strictly biological. He was particularly interested in insects and birds and began to write on these subjects in 1912. His interests can easily be followed by means of the appended bibliography. An early predilection for dragon flies never disappeared; thus we find him publishing papers on these insects throughout his career. On various trips to the Southern United States and to various countries

in Tropical America, he always noted first the character of the dragon flies present before he settled down to study mosquitoes or ticks.

While getting oriented in the field of Medical Entomology at Hopkins, Dr. Root did an excellent piece of research on the carriage of intestinal Protozoa of man by flies. Soon, however, he was deep in the study of the most important of all insects of medical interest, the mosquitoes. This work took him to the tropics and subtropics on a number of occasions and the results of his expeditions later found their way into print. Thus we find him writing about the mosquitoes of Lee County, Georgia, mosquitoes and other blood-sucking flies from Porto Rico, the blood-sucking arthropods of Tela, Honduras, and the mosquitoes of Brazil. At the time of his death Dr. Root was working with the collaboration of Dr. W. A. Hoffman on the last part of a comprehensive monograph on the sand-flies of the West Indies. Besides many scientific articles, Dr. Root took part in writing two books; he prepared the section on Medical Entomology in Outlines of Medical Zoology by Hegner, Cort and Root and in Animal Parasitology by Hegner, Root and Augustine.

Dr. Root's excursions into the field included a survey of work on malaria control in the southern United States, surveys of insects of medical interest in Porto Rico, a study of mosquito control at Leesburg, Georgia, a reconnaissance of work in medical entomology in the West Indies and the Central American Republics, including attendance at the Conference on Medical Problems in Tropical America at Kingston, Jamaica, in 1924, to which he was a delegate from the Johns Hopkins University, an extensive study of mosquitoes in Venezuela, a similar study in Brazil, and a survey of conditions on the island of Granada. The writer accompanied Dr. Root on several of these expeditions and always found him to be a most congenial companion.

Dr. Root belonged to a number of scientific societies, zoological, entomological and medical. Shortly before his death he was elected a charter member of the American Academy of Tropical Medicine which placed him among the fifty leaders in this subject in the United States. His colleagues miss his pleasant smile and charming companionship and Medical Entomology has suffered an irreparable loss as a result of his death.

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THE LARVAL STAGES OF *HYPODERMA LINEATUM* DEVILLERS AND *HYPODERMA BOVIS* DEGEER

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A review of the literature on the development of *Hypoderma* larvae shows that authors differ considerably as to the number of larval stages of this genus. To clear this confusion of opinion the writer has made a rather extensive study of these forms and presents in this paper what he considers conclusive evidence that there are only three larval stages instead of the four or five accepted by most workers.

The first larval stage of *Hypoderma* was unknown until Hinrichsen (*13*),[2] in 1888, discovered and first described larvae of *H. bovis* taken from the spinal canal of cattle. He recognized these larvae as different from the two stages found in the backs of cattle and therefore considered them first-stage larvae. In 1890, Curtice (*8*) noted similar larvae in the esophageal walls, under the pleura of the eleventh rib, and in the subcutaneous tissues of the back. These larvae he also designated as first-stage *H. bovis,* but later stated (*9,* p. *268*) that they were *H. lineatum.*

In 1890 the larva of *H. lineatum* as it appears within the eggshell just before hatching was briefly described and illustrated by Brauer (*2*). Curtice (*9, p. 270*) was inclined to consider these larvae as a different stage from those found in the esophagus. He states:

> The first stage as shown by Brauer is undoubtedly the form that emerges from the egg-shell—the oval-larva. The next known stage is that found in the oesophagus, the oesophageal, whether this stage may be shown to be different from the oval or whether intermediate stages may be found is yet to be proven. The oesophageal stage is identical with the subcutaneous and with the first form found in the skin tumors.

Riley (*23, p. 313*), in 1892, first described and illustrated the larva of *H. lineatum* as it appears upon hatching. This form was thought to represent a stage distinct from those previously known. In describing the esophageal larva he states:

> In the absence of any knowledge of an intermediate form, the larva found in the oesophagus may be considered as the second stage. The individuals vary in length from 11 to 14 mm. and are quite smooth, devoid of prickles, except some

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[2] Italic numbers in parentheses refer to Literature Cited.

minute ones which appear like black specks partly surrounding the anal spiracles and a few extremely minute ones just above the mouthparts.

The last two stages he designated as the third and fourth.

After the discovery of the supposed newly hatched larva four stages were generally recognized (Carpenter, Hewitt, and Reddin (*3*), McDougall (*16*), Hadwen (*11*), Phibbs (*20*)) until Laake (*14*) published his paper giving the distinguishing characteristics of *H. bovis* and *H. lineatum* in all of their larval stages. In this article Laake described what he considered another stage of *H. lineatum,* making the total number five, according to his ideas. Phibbs (*21*) later described what he considered a corresponding stage in *H. bovis.*

Since the publication of Laake's description of the supposed new stage in *H. lineatum* and Phibbs's description of a corresponding new stage in *H. bovis* five stages have been recognized by most investigators (Laake (*14*), (*15*), Phibbs (*21*), Warburton (*27*), Carpenter, Phibbs, and Slattery (*4*), Hadwen and Fulton (*12*), Carpenter (*5*), Bishopp, *et al.* (*1*), Mote (*18*), Case (*6*).

Other investigators do not accept five stages but hold to the older theory of four (Patton and Evans (*19*), MacDougall (*17*), Stevenson (*26*)).

Still other investigators recognize only three stages, their principal argument being that *Hypoderma* must have only three, since all other related oestrids are considered as having three larval stages. Gedoelst (*10*) published an article in which he advanced arguments to show that there are only three stages. His views, however, have not been accepted by most investigators. He pointed out the similarity of the cephalopharyngeal skeleton in the so-called first three stages and the general arrangement of the spiny armature in the so-called first and second stages. The increased size of the spines on the terminal segment and the increase in size of posterior spiracles in the third stage he attributed to a continuation of the process of chitinization. He also stated that no molting forms have been found among larvae before they have reached the position in the back of the host. In refutation, Laake (*15*) advanced further proof of five stages in *Hypoderma* and reported finding two specimens, one from the esophagus and another from the diaphragm, that were molting from the second to the third stage. Laake attempted to show that there are three distinct advances in the sizes of the mouth parts prior to the penultimate stage. These advances he attributed to two molts. He reported also a distinct difference in the number of spines on corresponding segments of newly hatched and smaller larvae found in the esophagus. He stated that the third stage is spineless on all but the first and last segments. Investigators in Germany generally recognize three stages (Spann (*24, 25*), Reisinger (*22*)).

All investigators recognize the last two stages in the back of the host as distinct, and also the newly hatched larva as distinct from the penultimate and ultimate. The difference in opinion is in the number of stages between the newly hatched and the penultimate larva. In general, those adhering to the theory of five stages attempt to show an increase in the size of cephalopharyngeal sclerites and posterior spiracles and a change in the armature of the newly hatched larvae, larvae measuring 3 mm. to 14 mm. found in the esophagus and elsewhere, and those later found under the skin of the back. Those authors who recognize only four stages consider the newly hatched larva a stage distinctly different from the larvae found in the esophagus and under the back before molting.

The writer will take up the arguments that have been advanced and will attempt to disprove them, or will give what he believes to be satisfactory explanations for the slight changes that take place as the first-stage larva becomes larger. Larvae of *Hypoderma lineatum* were used in this study.

OCCURRENCE OF MOLTS

Molting larvae in the back of the host are not uncommon. A large number of specimens were extracted and examined and many were found to be molting to the penultimate or second stage and others to the ultimate or third stage. However, no molting larvae have been reported from the time the newly hatched larvae penetrate the skin until they are later found in the esophagus. Owing to the greatly increased size and the changes in general appearance of larvae that have reached this location, these larvae have been considered as representing a distinct stage.

Laake (*15*) reports finding two larvae approximately 13 mm. in length molting from the second to the third stage. One was taken from the esophagus and the other from the diaphragm. In the case of the latter larva, especially, he believed that there was a true molt, as it exhibited what he considered the partly discarded exuvium. He kindly loaned the specimen to the writer, who examined it and found that it did not possess characteristics of a molting larva. A molt in Oestridae and other related dipterous larvae is characterized by a complete shedding of the exuvium together with the spiny armature, cephalopharyngeal sclerites, and posterior spiracles. For some time before the exuvium and other parts are shed, the replacements, in addition to the parts displaced, are clearly visible.

In the specimen just referred to there could be found no new set of cephalopharyngeal sclerites, no posterior spiracles, nor even new caudal spines, which would have been clearly visible beneath the partly shed exuvium in the case of an actual molt. From a portion of the larva (segments 2 to 8) Laake had separated what he considered the exuvium,

exposing what he considered the third stage. This divested portion did not possess the minute, but distinct, spines that are normally present on the so-called third stage.

As an explanation of the divestment, apparent on the specimen above mentioned, it was demonstrated that an outer layer, or epidermis, could be readily separated and removed from the dermis of larvae of practically all sizes found in the esophagus, and even from penultimate or second-stage larvae that were not approaching a molt. Stained sections reveal that this portion of the cuticle, removable by manipulation, is made up of one layer only, whereas an exuvium is composed of two distinct layers. It seems probable that Laake's supposedly molting specimen had been partly divested by some friction or hazard incidental to the butchering operation. Therefore, his specimen cannot be considered as representing a valid molt. Nor are there later records of the occurrence of a molt, except into the penultimate stage.

The writer examined approximately one thousand larvae, measuring 3 mm. to 14 mm., taken from the esophagi of cattle. No molting forms were found. Surely, if such a phenomenon normally occurs it would have been found repeatedly by various investigators who have examined hundreds of young larvae from the esophagus and other parts of the host.

CEPHALOPHARYNGEAL SCLERITES

All authors recognize the similarity in appearance of the sclerotized mouth parts in *Hypoderma* larvae of all sizes up to the penultimate stage. The same characteristics that distinguish newly hatched larvae of *H. bovis* from those of *H. lineatum* are found in all larvae of these species prior to the penultimate stage. Some authors, however, attempt to point out a distinct difference in size of the mouth hooks of larvae newly hatched, and those in the so-called second and third stages. Phibbs (*21*) states that the mouth hooks of *H. bovis* are somewhat smaller in the second and third stages, although he gives no measurements. Laake (*15*), however, compares the average measurement of the cephalopharyngeal sclerites of three newly hatched larvae, of three that he considered to be in the second stage, and of three in the third stage. He gives the length of the cephalopharyngeal sclerites of these three stages as 115.6, 117.1, and 125.5 microns, respectively, indicating a slight progressive increase in size of these parts. The number of larvae used in making these comparisons was not large enough to justify the conclusion, as his three averages fall well within the range of the measurements of each group presented in table I in this paper.

To show that there is no appreciable difference in size of the cephalopharyngeal sclerites of the young larvae, the writer presents (table 1)

TABLE I.—*Number of Hypoderma lineatum larvae having cephalopharyngeal sclerites of various lengths among 37 in each of three groups, viz. (1) newly hatched, (2) from esophagus and measuring 4 to 8.5 mm. in length, (3) extracted from backs of cattle before molting to the penultimate stage*

Groups of larvae	Larvae having sclerites of various lengths[1]									Total larvae of each group	Average length of sclerites in microns for each group
	104 microns	108 microns	112 microns	116 microns	120 microns	124 microns	128 microns	132 microns	136 microns		
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	
Newly hatched	0	2	3	4	10	11	5	2	0	37	121.19
From esophagus ...	1	2	1	6	7	12	6	1	1	37	121.40
From backs	1	0	2	4	9	12	6	2	1	37	122.16

[1] ± 2 microns.

measurements of these parts from the tips of the crescent-shaped hooks to the tips of the pharyngeal sclerites in 37 *Hypoderma lineatum* larvae, newly hatched; in 37 measuring from 4 to 8.5 mm. in length taken from the esophagus, and heretofore considered as being of the second stage; and in 37 extracted from the back, and heretofore considered as being of the third stage.

From the range in the length of sclerites—108 to 132 microns; 104 to 136 microns; and 104 to 136 microns, respectively—it is clearly evident that the sclerotized mouth parts are the same in all three groups. The averages, 121.19, 121.40, and 122.16 microns, do not indicate an appreciable difference in size.

It is logical to assume that a difference in size and structure of the mouth parts would be evident had a molt occurred. In other oestrids and dipterous larvae in general, a distinct difference in size and structure of the cephalopharyngeal sclerites is noted at each molt. For two, or even one, molt to occur and the cephalopharyngeal sclerites to be replaced by identical ones would represent a very aberrant type of larval development.

SPINES

Various investigators have reported a spineless stage of *Hypoderma,* that is, spineless on all segments except the first and last. Hinrichsen (*13*), the first to recover a larvae from the spinal canal, reports it as spineless. Riley (*23, p. 309, 313*) also stated that the larvae recovered from the esophagus and subcutaneous tissues of the back were spineless. A spineless stage has been generally recognized as being a distinct stage (Laake (*14*), (*15*), Carpenter, Phibbs, and Slattery (*4*), Cross (*7*), Patten (*19*), Warburten (*27*), Bishopp, *et al.* (*1*), Hadwen and Fulton (*12*), Mote (*18, p. 457, 467*)).

MacDougall (*17, p. 83*), on the contrary, recognizes the spiny armature normally present on the so-called "spineless" stage, as well as similarities in the cephalopharyngeal skeletons of the so-called second and third stages. He states:

> It is very difficult to make sure of the number of moults in dealing with these larvae (Hypoderma) * * * There is no doubt about there being at least four larval stages with recognizable differences. Laake in the United States has described five stages and four moults. It may be so but * * * I am not absolutely convinced that there are five stages.
>
> I am buttressed in my opinion by an intensive set of measurements of mouth-hooks and sephalo-pharyngeal skeleton made in my laboratory by Mr. J. W. M'Hardy, B. Sc., from a large series of larvae taken from infested gullets. Further, Laake's third-stage larva is distinguished by the term "spineless" (spines, though present at the anterior and posterior ends, are said to be absent from segments 2 to 10), but Mr. M'Hardy in some microscopic preparations on loan from Carpenter found one containing fourth-stage (Laake's fourth stage) spiracle

rudiments as well as third-stage (Laake's third stage) spiracles; the larva had been ready to moult to the fourth stagge, and yet it was spined on the body segments in the definite arrangement typical of Laake's second stage.

The writer examined a large number of larvae from the backs of cattle. Some of these were molting to the penultimate or true second stage, and by comparing them with the smaller larvae (so-called second stage of Laake) from gullets of cattle, proved that the number and distribution of spines is identical, except that they are spread over a larger area because of the growth of the larvae, as contended by MacDougall.

Furthermore, by examining and counting the spines on a number of newly hatched larvae it was revealed that here, again, the number is the same as on the second and third stages described by Laake. The larvae, upon hatching from the egg, are very small and have a very spiny appearance because of the large number of spines on the small area. As the larvae grow the integument spreads but the spines remain practically the same size. The distance between the spines is thus naturally increased, seemingly a change of armature. The distance between the spines is in direct proportion to the spread of the integument, as revealed by making measurements of various sizes of larvae of stages preceding those found in the back.

In order to compare the number of spines on larvae of various ages a count was made of the number of spines in the anterior row of the ventral half of segment 6. The spines are larger in the anterior rows, especially on the ventral half of the segments, making possible greater accuracy in counting. This difference in size of spines in the anterior rows, and especially on the ventral half, is clearly evident on larvae of all sizes—further evidence that there is no change of armature.

Table 2 presents the results of these counts. From the variations and averages it can be clearly seen that the numbers of spines are practically the same. The slight differences in average may be attributed to individual variations.

In order to determine whether any of the larvae found under the skin of the back are spineless, as many investigators believe, a series of 175 larvae generously supplied by C. E. Smith, of the Bureau of Animal Industry, were examined. Fifteen larvae of this series were yielding a thin layer of the cuticula, exposing a spineless inner layer. Larvae in this condition did not have the firm appearance characteristic of the others in the lot, but were flaccid and when punctured yielded what appeared to be watery disintegrated tissues. Probably some of the larvae were dead when extracted; in others cytolysis had possibly begun before effective preservation, weakening the junction between the two layers of the cuticula.

TABLE 2.—*Number of Hypoderma lineatum larvae among three groups—(1) newly hatched, (2) from esophagus, (3) extracted from backs of cattle before molting to the penultimate stage—having various numbers of spines in the anterior row on the ventral half of segment 6*

Groups of larvae	Larvae having various numbers of spines							Total larvae in each group	Average spines for each group
	28 spines	29 spines	30 spines	31 spines	32 spines	33 spines	34 spines		
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
Newly hatched	1	4	3	6	1	0	0	15	30.13
From esophagus	3	4	6	12	5	3	2	35	30.83
From backs	5	4	6	8	9	1	2	35	30.65

To substantiate the belief that the two layers of the cuticle separate more readily after death and partial disintegration, a number of living larvae, in the so-called third stage, freshly extracted from the backs of cattle, were placed in physiological salt solution for approximately 15 hours. At the end of this period the larvae were dead and in every case the epidermis was either partially removed or yielded to removal by manipulation more easily than in living specimens.

Such larvae, in the process of being mounted on slides, lost practically all of the epidermis, together with the spiny armature, except for small patches, usually on the first and last segments. Such a process was not the shedding of an exuvia, as this portion of the cuticula is thinner and more delicate than normal exuvia. Nor did the larvae show such new parts as were found in all truly molting larvae in the same lot of specimens. It is probable that such disintegrating larvae are partly responsible for the belief that a spineless stage occurs. Larvae normal in appearance retained their full armature when carefully mounted. All of the larvae that were preparing to molt were found to possess the spiny armature of the smaller larvae.

The fact that all these larvae from the back, normal in appearance and a large percentage already preparing to molt, were spined in a manner typical of newly hatched and esophageal specimens, should be convincing evidence that they were all of the same stage and that a spineless form does not occur.

The outstanding difference noted between newly hatched larvae, larvae from the esophagus (Laake's second stage), and those from the back is in the size of the spines on the last segment. This difference in size is largely responsible for the belief that these larvae are not all of the same stage. Although the spines on this segment are similarly arranged in all larvae up to the penultimate stage, an increase in size is noted in the spines as the larvae become larger.

It can be demonstrated that this increase in the size of the spines is due to the addition of a brownish-black formation, probably a process of sclerotization. To prove this point measurements were made to determine the average diameter of four of the largest spines found on the caudal segments of larvae of different sizes taken from the esophagus and generally considered to be of the same stage. In making this study three groups of larvae were used—those measuring 3.5 mm. to 5.0 mm., 7.5 mm. to 9.5 mm., and 10.5 mm. to 14.0 mm. The average width in 20 of the first group ranged from 8 to 12 microns, with an average of 9.08 microns; in the second group (14 larvae) from 12 to 20 microns, with an average of 15.07 microns; and in the third group (10 larvae) from 16 to 24 microns, with an average of 20.2 microns. The range and average for each group clearly indicates that this change is gradual; and since

the larvae from which these measurements were made are generally considered to be in the same stage (so-called second), the increase cannot be attributed to a molt.

The brownish deposit seen at the base of the spines as larvae in the same stage become older is not peculiar to *Hypoderma*. It is also very evident in first-stage larvae of *Gasterophilus* spp., third-stage larvae of *Cuterebra* spp. and *Cephenomyia* spp., and, to a lesser extent, in the third-stage larvae of some other oestrids.

POSTERIOR SPIRACLES

The posterior spiracles of newly hatched larvae consist of a pair of yellowish, apparently sclerotized atria, which lead into the main tracheal tubes.

The diameter of the spiracles of newly hatched larvae is less than in the larger larvae found in the esophagus and later under the skin of the back. The average width of the spiracles in the former is approximately 10 microns, whereas in the latter it is approximately 36 microns. This difference in size has been erroneously considered the result of a molt.

By examining a series of larvae of all sizes it was seen, as in the case of the spines on the last segment, that this increase is due to a formation around the spiracular atria.

The diameter of the spiracles is the same in newly hatched larvae and in the smaller esophageal larvae measuring up to 8 and 9 mm. After the esophageal larvae reach the size of approximately 9 to 10 mm. a faint brownish formation around these atria is noticed in some specimens. Larger larvae measuring 11 to 12 mm. show this in a greater percentage of cases and also show a denser formation. By the time larvae have reached the maximum length in the esophagus and the size later found in the back of the host, this formation has greatly increased and is very pronounced. The original atria found in newly hatched larvae, although longer, have not been altered, except for this dark formation around them.

That the increase in size is gradual, due to a deposition of a brownish material, possibly sclerotic material, may be demonstrated by examining the smaller and then the larger larvae found in the esophagus and generally recognized as being in the same stage. Seventy-five such larvae, measuring 3.5 to 7.5 mm., were examined. In no instance did the atria appear to have this formation. However, in a similar number of larvae from the same situation measuring 10 to 12 mm. this formation was perceptible in approximately 75 per cent. As these larvae are recognized by all investigators as being in the same stage, this should be

accepted as additional evidence that the change is gradual and continues in the larvae after they have reached the back of the host.

The spiracular atria also show an increase in length, although not so pronounced as the increase in diameter. This also is owing to growth. The average length of the atria in 12 newly hatched larvae was 23 microns, with a range of 20 to 26 microns. In 20 esophageal larvae measuring from 3 to 6 mm. the range was found to be 22 to 36 microns, with an average of 27.5 microns. In 15 esophageal larvae measuring 8 to 12 mm. the range was found to be 32 to 46 microns, with an average of 39.8 microns. As previously stated, larvae ranging from 3 to approximately 12 mm. are considered to be of the same stage, therefore this increase must be due to a gradual change and not connected with a molt.

Another (generic) example of this increase in length of the spiracular atria is found in the first-stage larvae of *Gasterophilus intestinalis* De G. In 10 newly hatched larvae of this species the average length of the spiracular atria was 257.04 microns, with a range of 243.6 to 268.8 microns, whereas, among a similar number of first-stage larvae approaching their maximum length, the average length of the atria was 349.86 microns with a range of 327.6 to 369.6 microns.

An increase in diameter of the posterior spiracles or stigmal plates in the older larvae within a stage is also noted in several other species of Oestridae. This is especially evident in second-stage and third-stage larvae of *Cephenomyia* spp. and also in third-stage larvae of a species of *Cuterebra*. Also the spiracles of *Hypoderma* in the penultimate, or second stage, and the ultimate, or third stage, become thicker and darker.

HYPODERMA BOVIS

The conclusion that there are only three larval stages has been based, as previously stated, on material of *H. lineatum*. Although the quantity of material of *H. bovis* was limited, indications are clear that there are only three larval stages in this species, because of the similarity of cephalopharyngeal sclerites and spiny armature of larvae newly hatched from the egg, of medium-sized larvae found in the spinal canal, and of those later found under the skin of the back.

SUMMARY

It has been the general opinion of most investigators that *Hypoderma lineatum* and *H. bovis* pass through either four or five stages in their larval development. Results from the present study indicate that there are only three stages, because:

(1) Larvae actually in the process of molting from the first to the so-called second stage and from this to the so-called third stage have not

been found, although hundreds of larvae have been examined by many workers.

(2) Numerous measurements of cephalopharyngeal sclerites indicate that these parts are identical in larvae heretofore considered as representing three instars. It is reasonable to assume that a definite change in size or structure of these parts should be evident if molts occurred.

(3) Counts of the number of spines on the same area on larvae of various sizes indicate that the spiny armature on the intermediate segments is the same and that the difference in appearance is due to increase in the area of the integument.

(4) Normal larvae found in the back and generally regarded as belonging to a "spineless" third stage are not spineless, but instead are armed with the same number of spines as are smaller larvae. Furthermore, all larvae examined that were approaching a molt bear their original armature superinmposed on that of the penultimate stage.

(5) The larger larvae found in the esophagus and those that have reached the back gradually develop a sclerotic area around the spiracular lumina. Like the continuous growth of the spines, this process of sclerotization appears to be independent of molts.

(6) Except for a slight progressive increase in length, the spiracular atria are similar in larvae of all sizes up to the penultimate or second stage.

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FOUR NEW TREMATODES FROM REPTILES

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A large number of reptiles from the vicinity of Baton Rouge, Louisiana, were examined for parasites during the spring of 1932. In identifying the trematodes collected the forms described in this paper were found. The writer wishes to express his sincere appreciation to Professor Henry B. Ward for his valued counsel and criticism.

Protenes vitellosus n. sp. (Fig. 1)

Description: *Protenes*. Body elongated, flattened, 2.88 to 4.03 mm. in length by 0.4 to 0.53 mm. in width. Cuticula beset with small spines anterior to ovary. Acetabulum 0.1 mm. in diameter at posterior end of anterior body fourth. Oral sucker subterminal, 0.1 by 0.13 mm.; prepharynx 15 to 45 μ long; pharynx 66 by 99 μ, divided into elongated quadrants; esophagus 0.16 to 0.2 mm.; intestinal crura terminate posterior to testes. Testes, 0.18 by 0.23 mm., lie in tandem in posterior body fourth; cirrus sac extends from posterior dorsal margin of acetabulum to genital pore on dorsal surface near left lateral margin of body just posterior to crural bifurcation. It passes ventral to left crus and contains a straight seminal vesicle, pars prostatica, ductus ejaculatorius and a protrusible cirrus. Ovary, 0.1 by 0.14 mm., medianly located in posterior part of first body third. Mehlis' gland posterior to ovary; Laurer's canal present; seminal receptacle lacking; vitelline reservoir present. Vitellaria arranged in from seven to nine follicular groups which extend from ovary to or posterior to the anterior testis. Left field of vitellaria more extensive than right, extending in some specimens posterior to both testes. Uterus intercrural, descending coils on right distinct from ascending coils on left side of body; coils do not extend posterior to anterior margin of anterior testis. Metraterm 0.19 mm. long. Eggs average 22 by 40 μ. Excretory bladder dorsal; extends from posterior tip of body to Mehlis' gland, where it bifurcates. The rami terminate immediately posterior to acetabulum.

Host: *Pseudemys elegans*.

Location: Small intestine.

Distribution: North America (United States, Baton Rouge, Louisiana).

Type Specimens: Ward Helminthological Collection, University of Illinois, Urbana, Illinois. Accession numbers 33.77, 33.78, and 33.79.

Remarks: Barker and Covey, 1911, created the subgenus *Protenes* and included in it *P. leptus* Barker and Covey, 1911, and *Telorchis angustum* Stafford, 1900. Stunkard, 1915, considered the characteristics of *Protenes* as being sufficiently different from those of the genus *Telorchis* to allow its being considered a distinct genus.

Protenes vitellosus may be distinguished from *P. leptus*, the species most similar to it, by its much larger size, the absence of a seminal receptacle and the distribution of the vitellaria. In *P. leptus* the vitellaria begin just posterior to the ovary and terminate anterior to the testes while in *P. vitellosus* the glands extend from the ovary to or posterior to

the anterior testis. The eggs of *P. leptus* average 23 by 51 μ, those of *P. vitellosus* 22 by 40 μ.

Thus far no generic diagnosis nor key to the species has been given for Protenes and for this reason the following diagnosis and key are given.

Generic Diagnosis: Small, flat distomes parasitic in reptiles. Length 1.28 to 4.03 mm., breadth 0.25 to 0.53 mm. Cuticula spiny. Acetabulum slightly smaller than oral sucker, near boundary of first and second body fourths. Prepharynx, pharynx, and esophagus present, crura extend posterior to testes. Testes in posterior fourth of body, tandem, intercrural. Cirrus sac extends from acetabulum to genital pore. Seminal vesicle, pars prostatica, and protrusible cirrus present. Genital pore near lateral margin, dorsal, near crural bifurcation. Ovary spherical, median, in second body fourth. Mehlis' gland posterior to ovary. Laurer's canal and vitelline reservoir present. Seminal receptacle present or lacking. Ascending and descending rami of uterus distinct, do not extend posterior to anterior margin of anterior testis. Metraterm present. Vitellaria extend from preacetabular to testicular zones. Excretory bladder "Y" shaped.

Key to the Species of Protenes

1 (2) Genital pore near right lateral margin of the body ..... *P. chapmani*
2 (1) Genital pore near left lateral margin of the body 3
3 (4) Vitellaria extend well into preacetabular region of the body. *P. angustus*
4 (5) Vitellaria begin a short distance posterior to ovary and terminate in front of the anterior testis at a distance equal to its diameter. Seminal receptacle present ..... *P. leptus*
5 (4) Vitellaria begin in ovarian zone, extend to or posterior to anterior testis. Seminal receptacle lacking ..... *P. vitellosus*

Cercorchis singularis n. sp. (Figs. 3, 12 and 13)

Description: *Cercorchis*. Body elongate, 7.68 to 14.1 mm. long by 0.63 to 0.84 mm. wide; both extremities bluntly rounded; body anterior to ovary very flat, posterior to ovary distended with eggs. Cuticula shows decreasing spination from anterior end to beginning of last third of body length; no spines seen on posterior third. Acetabulum at anterior end of second body fourth, 0.14 mm. in diameter. Oral sucker subterminal, 0.12 by 0.14 mm.; prepharynx short, muscular; pharynx 0.11 mm.; esophagus variable in length, 0.21 mm. long in average sized specimen; intestinal crura extend to posterior end of body. Testes tandem, between ends of intestinal crura, 0.25 by 0.31 mm. Cirrus sac 0.1 mm. by 3.91 mm.; extends from ovary almost to acetabulum where it empties into a large genital sinus. Seminal vesicle occupies posterior fourth of cirrus sac; pars prostatica well developed, 1.03 mm. long; ductus ejaculatorius 2.06 mm. long. Presence or absence of protrusible cirrus could not be determined. Ovary, 0.21 in diameter, located slightly toward right side, immediately posterior to middle of body length. Mehlis' gland, Laurer's canal, and vitelline reservoir present; seminal receptacle absent. Uterus largely intercrural; arranged in transverse coils which overlap slightly in center. Descending portion lies on right side of body. Metraterm, 0.06 by 2.1 mm., empties into genital sinus anterior to opening of cirrus sac. Near its distal end it is surrounded by large muscular bulb, 0.13 mm. in diameter. This bulb composed of large number of circular muscles and a few longitudinal fibers lying next to lumen of metraterm. A group of ten to twelve large gland cells, 0.05 by 0.07 mm., lie antero-dorsal to this bulb and seem to empty into terminal end of metraterm. Genital sinus passes to left of acetabulum to

genital pore which is located slightly to left of median line a short distance anterior to acetabulum. Eggs measure 18 to 25 μ in length by 12 to 15 μ in width. Vitellaria arranged in indistinct follicular groups lying external to intestinal crura, extending from a point one-fourth distance from acetabulum to ovary to the anterior margin of anterior testis. Median excretory vesicle extends from posterior end of body to Mehlis' gland. Here it bifurcates and the rami extend a short distance anterior to acetabulum.

Host: *Pseudemys elegans* and *Chelydra serpentina.*

Location: Small intestine.

Distribution: North America (United States. Baton Rouge, Louisiana).

Type Specimens: Ward Helminthological Collection, University of Illinois, Urbana, Illinois, under accession numbers 33.81 and 33.82.

Remarks: The systematic position of the genus *Cercorchis* Lühe, 1900, has been both interesting and confusing with regard to its relationship to Telorchis Looss, 1899. However, Perkins, 1928, has discussed fully the history of the subfamily Telorchinae Looss, 1899, and the genera included in it. He defines the genera clearly and raises *Cercorchis,* which has been considered a subgenus of *Telorchis,* to generic rank. *Cercorchis* is distinguished from *Telorchis* by the fact that the genital pore lies near the acetabulum and is more median in *Cercorchis.* The testes in *Cercorchis* are always in the posterior body fourth while those in *Telorchis* are about half way between the acetabulum and posterior end. They are further distinguished by the extent of the vitellaria. In *Cercorchis* these glands do not extend posterior to the testes whereas in *Telorchis* they extend both posterior and dorsal to them. His generic diagnosis has been accepted in this paper and the species described here is included in it.

C. singularis is more closely related to *C. attenuatus* Goldberger, 1911, than to any other species in the genus. The two forms show specific differences, however, in that the acetabulum in the present form is located more posteriorly, the testes do not abut or overlap, the cirrus sac terminates dorsal to the ovary instead of extending only two-thirds of the distance to it, and the metraterm is correspondingly longer. Goldberger mentions the presence of a genital sinus into which the male and female ducts open but did not mention its size and it is not shown distinctly in his drawing. Apparently the atrium or genital sinus is much larger in the present form. Other differences between the two are the presence of the large muscular bulb surrounding the distal end of the metraterm and the more cephalic extent of the branches from the excretory bladder. In *C. attenuatus* they terminate posterior to the anterior limits of the vitellaria, while in the present material they terminate slightly in front of the acetabulum. In view of these differences it seems necessary to designate this distome as a new species of *Cercorchis* and the name *C. singularis* is suggested.

Neochasmus labeosus n. sp. (Figs. 5–9)

Description: *Neochasmus.* Body subcylindrical, 0.85 to 0.1 mm. long by 0.25 to 0.36 mm. in width. Cuticula smooth with exception of an oral crown of thirty-four spines measuring 19 μ in length. Acetabulum 0.11 by 0.14 mm., located at junction of first and second body thirds. Terminal oral sucker 0.09 by 0.14 mm.; prepharynx 0.02 to 0.04 mm. long; pharynx 0.05 by 0.06 mm.; esophagus about same length as prepharynx. Intestinal bifurcation occurs a short distance anterior to acetabulum and crura and in third fourth of body length. Ovoid testes, 0.07 by 0.11 mm., are obliquely placed in the dorsal half of the body and are intercrural. Large seminal vesicle coils vertically in dorsal half of body. Its posterior extremity lies mid-way between testes and acetabulum. Long coiled ejaculatory duct opens into an ovoid chamber anterior to dorsal surface of acetabulum. This chamber surrounded by small gland cells. No definite prostate region could be distinguished. A genital sinus leads from this chamber to genital pore which is located directly in front of acetabulum. Both acetabulum and genital sinus empty into common atrium which is bounded laterally by prominent lips or folds of body wall. An anterior boundary formed by single large fold which projects posteriorly, covering genital pore. Posterior boundary formed by a relatively inconspicuous fold. Ovary an irregular series of follicles transversely arranged in ventral region of body, immediately behind acetabulum. Mehlis' gland lies dorsal to it. Seminal receptacle present, anterior to Mehlis' gland. Vitelline reservoir lies posterior to Mehlis' gland. Laurer's canal present. Uterus coils posteriorly on ventral surface, passes anteriorly between testes. Metraterm, a long slender duct, enters the genital sinus immediately ventral and posterior to entrance of male duct. Vitellaria consist of large follicles irregularly placed in lateral body fields reaching from acetabulum to ends of crura and mesially to crura dorsally and ventrally. They approach dorsal median line in acetabular region but no connecting band present. Eggs 20 to 30 μ long by 12 to 19 μ wide. Excretory vesicle empties on dorsal surface near posterior end of body, passes anteriorly in center of the body. It bifurcates between testes and rami terminate lateral to pharynx.

Host: *Natrix rhombifera.*

Location: Intestine.

Distribution: North America (United States. Baton Rouge, Louisiana).

Type Specimens: Ward Helminthological Collection, University of Illinois, Urbana, Illinois, under accession number 33.82.

Remarks: The trematode described here is closely related to *Neochasmus umbellus* Van Cleve and Mueller, 1932, but the two forms are sufficiently different to preclude their being identical. They differ in the number of spines in the oral crown, in acetabular size, in the presence of a vestigial gonotyl in *N. umbellus,* in the presence of the conspicuous lip-like elevations forming the lateral walls of the genital atrium in the present species and the more extensively developed vitellaria in this form. The host relationship has not been definitely established for this genus. Thus far it has been reported only once from the fish *Micropterus salmoides.* In this paper, the second report on the genus, the host is a water snake, *Natrix rhombifera.*

The subfamily Neochasminae was erected by Van Cleave and Mueller, 1932, to receive the single genus *Neochasmus* for which the only species reported is *N. umbellus.* The subfamily Neochasminae was assigned to the family Heterophyidae Odhner. The assigning of the tre-

matode described here to the genus Neochasmus makes it necessary to emend slightly the subfamily and generic diagnoses given by the authors.

The statement in the subfamily diagnosis which reads, "Gonotyl vestigial, posterior to the genital pore," must be emended to read, Gonotyl, if present, vestigial, posterior to the genital pore.

The following changes in the generic diagnosis are necessary. "Small distomes living as adults in the alimentary canal of fishes" should read, Small distomes living as adults in the alimentary canal of fishes and reptiles. "Gonotyl rudimentary, appearing as a thickened area of the surface musculature just behind the genital pore" should read, Gonotyl, if present, rudimentary, appearing as a thickened area of the surface musculature just behind the genital pore. In the statement "Vitellaria follicular, in middle third of body, chiefly lateral but some follicles distributed across the entire width of the dorsal surface" delete "but some follicles distributed across the entire width of the dorsal surface."

Megacustis n. g.

Generic diagnosis: Body elongate, broadly oval in cross section. Cuticula beset with spines; ventral sucker smaller than oral sucker; pharynx only a little smaller than oral sucker; prepharynx and esophagus present; crural bifurcation close in front of acetabulum; crura reaching a little in front of posterior end; genital pore slightly lateral, close to bifurcation of crura; testes spherical, about equal in size, placed obliquely behind each other; cirrus sac of moderate size, extending behind the acetabulum; seminal vesicle coiled; pars prostatica very distinct; ovary situated immediately anterior to the middle of the body; seminal receptacle and Laurer's canal present; ascending and descending portions of uterus in transverse coils distinctly separate posterior to testes, many close transverse coils anterior to ovary; metraterm short; vitellaria extracrural, extending from acetabulum almost to ends of crura; excretory bladder weakly bifurcated, with two lateral bifurcated branches emptying into it near the anterior end.

Type of Genus: *Megacustis multispinosus.*

Host: Anolis carolinensis.

Location: Small Intestine.

Distribution: North America (United States. Baton Rouge, Louisiana).

Megacustis multispinosus n. sp. (Figs. 2, 4, 10 and 11)

Description: *Megacustis.* Body elongate and broadly oval in cross section. Entire cuticula thickly set with slender spines, 10 μ in length. Acetabulum, 0.21 mm. in diameter, located at junction of first and second fifths of body. Subterminal oral sucker measures 0.35 by 0.3 mm.; prepharynx 0.08 mm. long; pharynx 0.28 mm. in diameter; intestinal bifurcation 0.25 mm. in front of acetabulum; crura terminate 0.4 mm. from posterior end of body, the left being slightly the longer. Testes, 0.2 by 0.23 mm., obliquely placed in the fourth fifth of the body. Anterior one on the right side 0.25 mm. in front of other. Cirrus sac, 0.13 by 0.52 mm., begins at a point 0.25 mm. posterior to acetabulum and passes dorsal to it. Genital pore located to right of median line 0.06 mm. posterior to crural bifurcation. Greatly coiled seminal vesicle fills posterior third of cirrus sac, followed by pars prostatica, 0.27 mm. in length. Ductus ejaculatorius 0.04 mm. long Presence or absence of protrusible cirrus could not be determined. Ovary, 0.24 by 0.36 mm., located slightly toward right side a short distance anterior to center of body. Mehlis' gland, seminal receptacle, Laurer's canal, and vitelline reservoir present. Uterus passes posteriorly from Mehlis' gland on right side of body,

performing numerous transverse coils ventral to excretory bladder and intercrural field. It turns anteriorly at end of body to pass forward on left side. Coils overlap in median line in testicular region and remain overlapped in postovarian region. Ascending part passes to left of ovary and then turns toward median line. From this point intercrural space completely filled by numerous transverse coils. Metraterm extends from posterior margin of acetabulum to genital pore. Eggs 12 to 15 μ by 22 to 27 μ. Vitellaria arranged in extracrural follicular groups which extend from acetabulum to near ends of crura. Extremely large excretory vesicle occupies fully half the body space posterior to Mehlis' gland. It empties at posterior tip of body through a short, muscular duct. At its anterior end there is a slight indentation, due perhaps to pressure exerted by vesicle against Mehlis' gland, which gives the impression that bladder bifurcates into two short and broad rami. At a point 0.1 mm. from its anterior end vesicle receives a short lateral branch on each side which bifurcates immediately. One ramus extends anteriorly on each side along ventro-lateral surface to level of posterior margin of oral sucker. Posterior ramus extends in a similar position to end of crus.

Host: *Anolis carolinensis.*

Location: Small Intestine.

Distribution: North America (United States. Baton Rouge, Louisiana).

Type Specimens: Ward Helminthological Collection, University of Illinois, Urbana, Illinois, under accession numbers 33.75 and 33.76.

Remarks: This genus is included in the family Plagiorchidae as defined by Führmann, 1928, on the basis of its possessing every family characteristic used by him in his definition with the possible exception of the structure of the bladder. The presence of the large excretory bladder is characteristic of the family but the extreme shortness of its bifurcated portion in *Megacustis* and the arrangement of the two lateral branches seem peculiar to the genus. A study of the genera of the family was made and it was found that *Megacustis* is closely related to *Haplometroides* Odhner, 1911, *Spinometra* Mehra, 1932, and *Microderma* Mehra, 1932.

Megacustis may be separated from *Haplometroides* by the position of the suckers, the large pharynx, the much shorter esophagus, the longer crura, the longer cirrus sac, the position of the ovary which is farther posterior to the acetabulum, the large number of transverse uterine coils anterior to the ovary, the position of the genital pore nearer the crural bifurcation, and the greater distribution of the vitellaria.

Megacustis differs sharply from *Spinometra* in its smaller size, larger oral sucker and pharynx, shorter esophagus, smaller cirrus sac, much less developed metraterm, genital pore to right of median line and nearer crural bifurcation, slightly more anterior extent of vitellaria, and longer excretory bladder. No cirrus was seen in *Megacustis* while that of *Spinometra* is well developed and covered with spines.

Megacustis shows the following important differences from *Microderma:* an esophagus is present, the oral sucker is larger than the acetabulum, the acetabulum is much closer to the crural bifurcation, the pharynx is much larger, the ascending and descending coils of the uterus in the

body region posterior to the testes are more distinctly separated, there are many transverse coils of the uterus anterior to the ovary, the vitellaria are more fully developed and extend farther anteriad, the genital pore is close behind the crural bifurcation and is slightly to the right of the median line, and the excretory bladder lacks distinct rami and receives two lateral bifurcated branches near the anterior end.

Megacustis is more closely related to *Microderma* subfamily Lepodermatinae Looss than to *Haplometroides* subfamily Lepodermatinae or to *Spinometra* subfamily Styphlotreminae Baer. Mehra (1928) considered *Microderma* as being a connecting form between these two subfamilies and included it in Lepodermatinae as he had amended it in 1930. The genus *Megacustis* is placed in the subfamily Lepodermatinae as emended by Mehra.

SUMMARY

One new genus and four new species of trematodes are described. They are *Protenes vitellosus* n. sp. from the intestine of *Pseudemys elegans, Cercorchis singularis* n. sp. from the intestine of *Pseudemys elegans* and *Chelydra serpentina, Neochasmus labeosus* n. sp. from the intestine of *Natrix rhombifera,* and *Megacustis multispinosus* n. g. and n. sp. from the intestine of *Anolis carolinensis.*

P. vitellosus is compared to *P. leptus* Barker and Covey, 1911, a concise generic diagnosis and a key to the species of the genus is included.

The raising of the subgenus Cercorchis of the genus Telorchis by Perkins, 1928, to generic rank is accepted. *C. singularis* is compared to *C. attenuatus* Goldberger, 1911.

The genus *Neochasmus* is reported for the first time from a reptilian host. The close relationship of *N. labeosus* to *N. umbellus* Van Cleave and Mueller, 1932, is shown. The diagnoses of the sub-family Neochasminae Van Cleave and Mueller, 1932, and of the genus *Neochasmus* Van Cleave and Mueller, 1932, are emended.

Megacustis is placed in the family Plagiorchidae as defined by Führmann, 1928, and is compared to *Haplometroides* Odhner, 1911, *Spinometra* Mehra, 1932, and *Microderma* Mehra, 1932.

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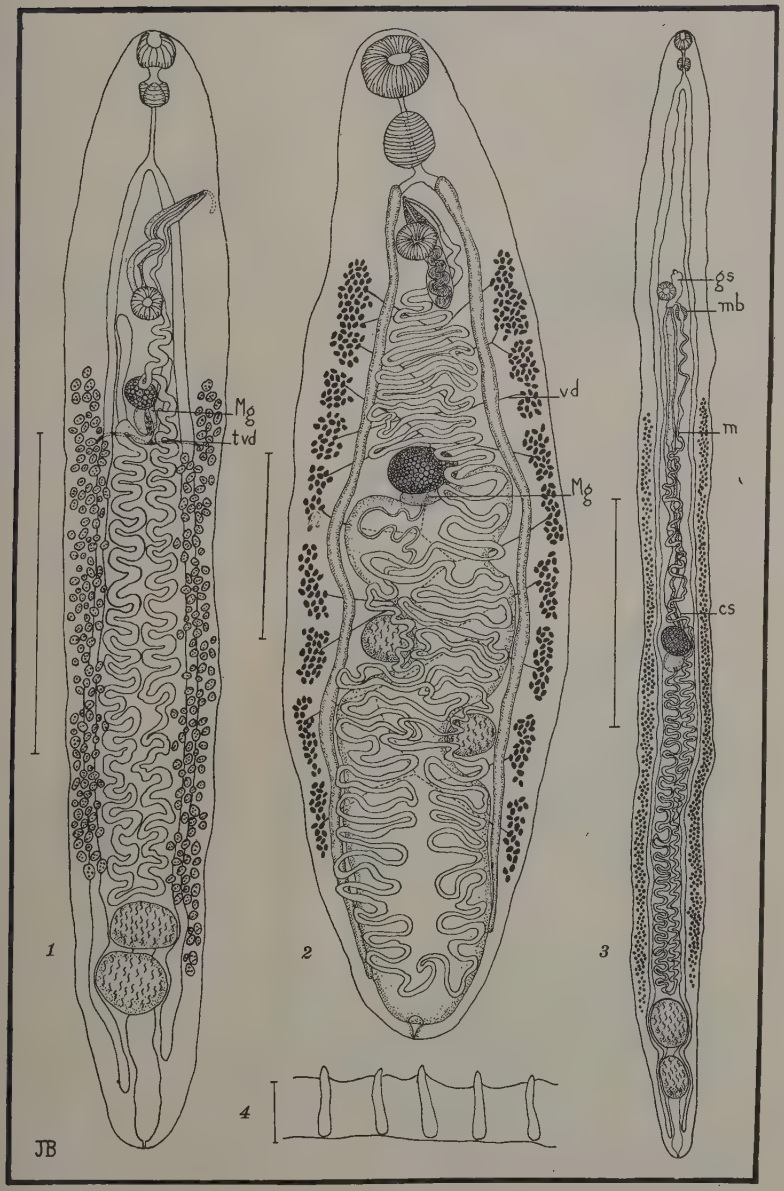
Explanation of Plates

All of the drawings were made with a camera lucida, with the exception of figure 11 which is a graphic reconstruction, and figure 10.

ac	acetabulum	mb	muscular bulb
cs	cirrus sac	Mg	Mehlis' gland
es	esophagus	ml	median lip
ex	excretory bladder	o	ovary
ga	genital atrium	os	oral sucker
gl	gland	ph	pharynx
gs	genital sinus	sr	seminal receptacle
i	intestine	sv	seminal vesicle
ll	lateral lip	tvd	transverse vitelline duct
m	metraterm	vd	vitelline duct

Figure 1. Ventral view of *Protenes vitellosus*. Scale 1.0 mm.
Figure 2. Ventral view of *Megacustis multispinosus*. Scale 1.0 mm.
Figure 3. Ventral view of *Cercorchis singularis*. Scale 2.0 mm.
Figure 4. Portion of cuticula of *Megacustis multispinosus* showing spines. Scale 10 μ.
Figure 5. Ventral view of *Neochasmus labeosus*. Scale 0.3 mm.
Figure 6. Lateral view of *N. labeosus*. Scale 0.3 mm.
Figure 7. Sagittal section of *N. labeosus* to the left of the median line. Scale 0.3 mm.
Figure 8. Cross section of *N. labeosus* through acetabular region. Scale 0.2 mm.
Figure 9. Lateral view of a spine from the oral crown of *N. labeosus*. Scale 10 μ
Figure 10. Diagram showing arrangement of spines of *Magacustis multispinosus*.
Figure 11. Lateral view of ovary and Mehlis' gland complex of *M. multispinosus*. Scale 0.2 mm.
Figure 12. Ventral view of *Cercorchis singularis* showing distal ends of genital ducts. Scale 0.5 mm.
Figure 13. Cross section of *C. singularis* through region of muscular bulb. Scale 0.3 mm.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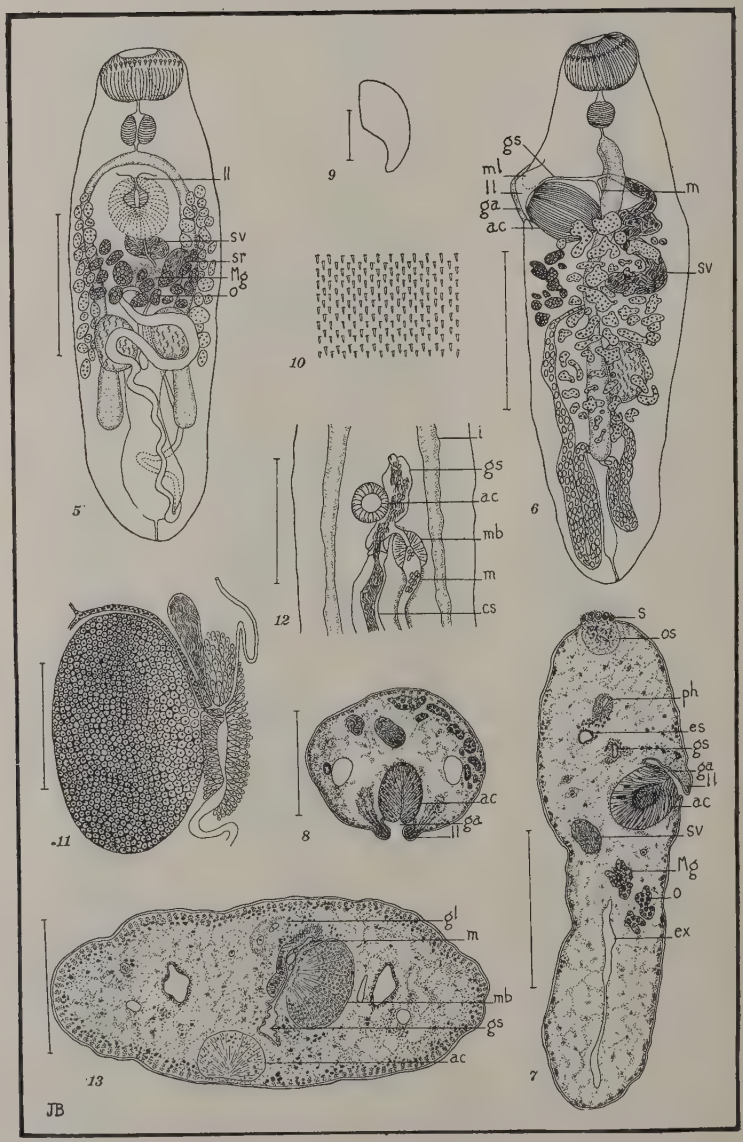
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PARHAMATOSPICULUM BUBICOLA N. SP., A NEW NEMATODE FROM BIRDS

PROF. K. I. SKRJABIN AND A. M. PETROW

State Institute of Helminthology, Moscow, U. S. S. R.,
Director Prof. K. I. Skrjabin

The species of nematode discussed in this paper was found in an owl, *Bubo bubo,* brought to the Institute of Helminthology for examination. The worms collected in the subcutaneous tissue were identified as a new species of the genus *Parhamatospiculum* Skrj. and Petrow, 1928, to which the name *P. bubicola* n. sp. is given.

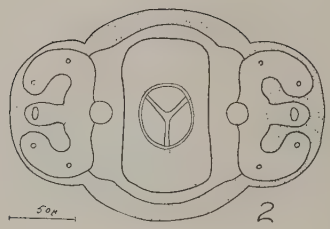
Parhamatospiculum bubicola n. sp.

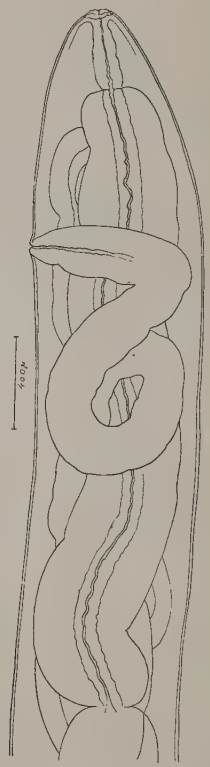
Description of the species. Large nematodes, light-gray in color, slightly narrowed towards both ends. Surface of cuticle covered with delicate wart-like formations most apparent on the distal portion of the female's body. Anterior end provided with cuticular cephalic disc of transversally oval form. Oral aperture terminal, surrounded by circumoral, hexangular, cuticular collar on both sides of which are two broad lateral papillae. On sides of circumoral collar are two lateral epaulet-like structures each divided into three lobes. Median lobe short and other

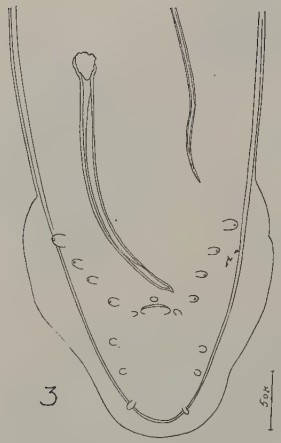
Fig. 1. *Parhamatospiculum bubicola,* natural size.

two larger, one being latero-dorsal and the other latero-ventral. Median lobe provided with one sessile papilla, and the two lateral lobes with two sessile papillae each, one located at the base and the other near the free tip of the epaulet-like structures. Cylindrical oesophagus double, in male 1/3 and in female 1/5 of total length. Anterior part of oesophagus to nerve ring very narrow and posterior part widened.

Male. 27–30 mm. long with maximal breadth 0.543–0.578 mm. At end of oesophagus breadth 0.490–0.542 mm. and in region of cloacal aperture 0.120–0.133 mm. Oesophagus 9.012–9.713 mm. long, and maximal breadth 0.332–0.350 mm. in posterior portion. Nerve ring 0.316–0.344 mm. from cephalic extremity. Caudal end with two delicate symmetrical alae with a length of 0.220–0.233 mm. and a maximal breadth of 0.0341 mm. Aperture of cloaca at 0.105–0.115 mm. from caudal end. On ventral surface of tail eight pairs of pedunculated papillae—four pairs pre-anal, one pair para-anal and three pairs post-anal. Anterior pre-anal papillae lateral and posterior somewhat nearer midline of body. Para-anal papillae on both sides of aperture of cloaca. Post-anal papillae sublateral, posterior pair nearer to tip of caudal end and two other pairs nearer to cloacal aperture. All eight pairs of papillae have form of a spear with a sharpened tip. Anterior lip of cloacal aperture provided with an unpaired sessile papilla. Here as in *Parhamatospiculum nodulosum* (Rud., 1819) projects a peculiar unpaired cylindrical formation situated medianly. Two unequal spicules with fine transverse striations. Right spicule 0.263–0.273 mm. long with a maximal width at its proximal end of 0.0124–0.0248 mm. Proximal end of right spicule widened with gutter-like form. Distal







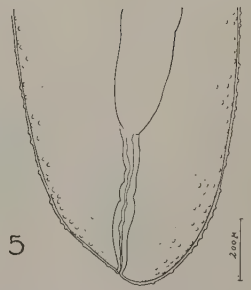


Fig. 2. *Parhamatospiculum bubicola,* anterior extermity, end-on view.
Fig. 3. *Parhamatospiculum bubicola,* male, caudal end, ventral view.
Fig. 4. *Parhamatospiculum bubicola,* female, cephalic end.
Fig. 5. *Parhamatospiculum bubicola,* female, caudal end.

end sharpened and middle part provided with single wing. Left spicule 3.224–3.238 mm. long and 0.0217 mm. wide in its anterior portion; thread-like with slightly widened proximal end and sharpened distal one. Gubernaculum absent.

Female. 54–60 mm. in length. Breadth in posterior portion of the oesophagus 0.945. Oesophagus 11.760–15.137 mm. long with maximal breadth in posterior portion 0.385–0.438 mm. Nerve ring 0.542 mm. from cephalic end. Tail tip conically rounded. On surface of cuticule clearly appear small, irregularly distributed wart-like formations. Anal aperture subterminal. Aperture of the vulva in anterior part of body at 0.857–0.980 mm. from cephalic end. Eggs oval 0.062–0.065 mm. in length and 0.034–0.043 mm. in breadth and containing larvae on deposition.

Differential diagnosis. The new species here described, *Parhamatospiculum bubicola* n. sp., is distinguished from the only other representative of the genus, *P. nodulosum* (Rud., 1819), in the following respects:

1. The length of the left spicule in *Pharhamatospiculum bubicola* (3.224–3.238) is considerably greater than that in *P. nodulosum* (1.980–2.225).

2. In *Parhamatospiculum nodulosum* the distal end of the left spicule is provided with a claw-like formation absent in *Parhamatospiculum bubicola* n. sp.

3. The caudal end in the male of *Parhamatospiculum nodulosum* is provided with nine pairs of papillae and in *Parhamatospiculum bubicola* n. sp. there are only eight. Besides, in *P. nodulosum* two out of the four post-anal pairs are located subventrally and two submedianly, whereas in *P. bubicola* all three post-anal pairs are situated sublaterally.

TABLE 1.—*Comparative measurements of Parhamatospiculum nodulosum (Rud. 1819) and Parhamatospiculum bubicola nov. sp.*

	Parhamatospiculum nodulosum (Rud. 1819)		*Parhamatospiculum bubicola* n. sp.	
	Male	Female	Male	Female
Body length	25–30*	65–72	27–30	54–60
Body breadth	0.623–0.667	1.112–1.202	0.542–0.578	0.962– 1.068
Oesophagus length	6.319–6.842	7.298–7.387	9.012–9.713	11.76 –15.14
Oesophagus maximal breadth	0.286	0.322	0.332–0.350	0.385– 0.438
Distance from the nerve ring to the cephalic end	0.209–0.212	0.210–0.217	0.316–0.344	0.542
Right spicule (length)	0.275–0.287	.....	0.263–0.273	.....
Left spicule (length)	1.980–2.225	.....	3.224–3.238	.....
Distance from cloaca to caudal end	0.075–0.087	.....	0.105–0.115	.....
Distance from vulva to cephalic end	.....	1.552	.....	0.857– 0.980
Size of egg		0.060–0.065 × 0.038–0.040		0.062– 0.065 × 0.034– 0.043
Length of oesophagus in relation to total length of body	1/4.2	1/9.4	1/3.0	1/4.0–1/5.0

* All measurements in mm.

KEY TO THE SPECIES OF THE GENUS PARHAMATOSPICULUM

1. Surface of the cuticle in the female covered with delicate wart-like formations. Left spicule 3.22–3.24 mm. long without a claw-like protuberance at the distal end. Eight pairs of papillae, three of which are post-anal pairs situated sublaterally. Parasites of owls.
Parhamatospiculum bubicola Skrj. and Petrow, 1933.

2. No wart-like formations on the cuticle of the female. Left spicule 1.98–2.23 in length with a claw-like distal end. Nine pairs of papillae of which two post-anal papillae are sublateral and two submedian. Parasites of birds of the family Laniidae.

Parhamatospiculum nodulosum (Rud., 1819) Skrj. and Petrow 1928.

Reference

Skrjabin, K. I., and A. M. Petrow. 1928.—The systematic position of *Filaria nodulosum* Rud., 1819 (*Parhamatospiculum* n. g.). Ann. Trop. Med. and Parasit., 22: 161–168.

ON THE NEMATODE FAUNA OF THE SHREW-MOUSE, *SOREX ARANEUS* L.

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Director Prof. K. I. Skrjabin

In this paper are given the description of some new species of nematodes, found in one of three specimens of shrew-mice, *Sorex araneus* L., collected in the Middle-Volga region (U. S. S. R.).

Suborder Strongylata Raill. et Henry, 1013.
Family Metastrongylidae Leiper.
Subfamily Crenosomatinae Skrj., 1933.
Crenosoma skrjabini, n. sp. (Figs. 1–5.).

In the lungs of a female shrew-mouse, *Sorex araneus* L. were found six specimens—three males and three females—of nematodes of the genus *Crenosoma* Molin, 1861, which on close examination proved to belong to a new species. This new form is designated as *Crenosoma skrjabini* in honor of Prof. K. I. Skrjabin.

Specific description. Very small nematodes of light yellow color; slightly attenuated toward the two extremities. Cuticula more inflated at posterior end than at anterior, having an annular appearance; longitudinal striations and spines common to all the other species of *Crenosoma* absent.

Male. Length 2.78 mm. and maximum width 0.161 mm.; width in oesophageal region 0.148 mm. and in cloacal 0.096 mm. Terminal buccal cavity leads into oesophagus, slightly dilated posteriorly. Length of oesophagus 0.296 mm. and width, posterior part, 0.036 mm.; length one-tenth of entire worm. Well developed trilobed bursa; central lobe more feebly developed and very slightly marked off from the lateral lobes. Ventro-ventral rays arising from common trunk, close together, parallel, 0.032 mm. long and 0.005 mm. wide;* latero-ventral rays, 0.044 by 0.005 mm.; antero-lateral rays arising from common trunk with other lateral rays, 0.038 by 0.0075 mm.; medio-lateral and postero-lateral rays, lying close together and parallel, 0.022 by 0.0055 and 0.040 by 0.004 mm. respectvely; externo-dorsal rays short arising from common trunk with dorsal, 0.036 mm. by 0.006 mm.; dorsal ray, doubled posteriorly, 0.029 by 0.006 mm. Spicules equal of light brownish color, hollowed in appearance and attenuated toward pointed tips; proximal ends provided with small cylindrical protuberances; spicules measure 0.120 by 0.004 mm. Small outgrowth on dorsal side of each spicule as in other species of *Crenosoma.* Gubernaculum in ventral portion, convex, up to 0.021 mm. in length with width of 0.0017 mm. at convex part.

Female. The three females had the anterior parts torn off and consequently total length, length of oesophagus and that of certain other organs could not be established. Vulva located in anterior portion of body, 2.447 mm. from posterior tip; maximal breadth of body 0.29 mm., in region of vulva 0.276 mm., and at anus 0.080 mm.; distance of anus from tip of tail 0.114–0.129 mm. Orifice of vulva trans-

* The length is taken for each ray from the angle of adjacency to the body; the width is that of the middle portion.

verse slit. Cuticula in posterior part of body of female also annulated. Tip of tail sharpened with two feebly developed papillae like those of *Crenosoma taiga* Skrjabin and Petrow, 1928. Viviparous. Larvae spirally bent, spindle-shaped, length 0.644–0.660 mm. and width 0.015 mm.

Differential diagnosis. The genus *Crenosoma* Molin 1861, includes only three previously described species: *C. striatum* (Zeder, 1800), *C. vulpis* (Dujardin, 1845), and *C. taiga* Skrjabin et Petrow, 1928. By the absence of longitudinal striae and spines on the annulated cuticular formations *C. skrjabini* n. sp. differs from the other species of *Crenosoma* in which these structures are found either on the whole length of the body or only on the anterior part. The spicules in *C. skrjabini,* have as in the other three species of the genus a dorsal protuberance but they are much shorter, the spicules in *C. triatum* being 0.24 mm. long, those of *C. vulpis,* 0.37 and those of *C. taiga* 0.28–0.29 mm.

Suborder Trichocephalata Skrjabin et Schulz, 1928.
Family Trichocephalidae Baird, 1853.
Trichocephalus busuluk n. sp.

In the caecum of a female shrew-mouse were found seven nematodes (five males and two females) belonging to the genus *Trichocephalus* Schrank, 1788. These worms are placed in a new species which we have names *Trichocephalus busuluk.*

Description of the species. Small nematodes whitish-yellow with central portion of body more vividly colored, than posterior and anterior. Cuticule without striations. Tip of cephalic portion hooklike, curved.

Male. Mouth terminal. Length 7.5 mm.; maximal width 0.130 mm.; width in oesophageal region 0.048 and in cloacal region 0.024 mm. Length of oesophagus 5.313 mm., one-seventh total body length. Spicule with blunted tip hooked towards end of body; length 0.729–0.876 mm.; width in central and caudal portions 0.004 mm. Proximal end of spicule with cap-shaped swelling markedly separated with breadth of 0.019 mm. and length of 0.0144 mm. Sheath of spicule longer than spicule itself, 0.836–1.064 mm. with width of 0.008–0.016 mm. Spicule sheath armed with minute spines and dilated towards distal extremity.

Female. More intensely colored than the male, particularly in intestinal region. Total length 9.5 mm.; maximal width 0.132 mm.; breadth of the body in the oesophageal portion 0.012; at the vulva 0.088, and at the anus 0.012 mm. Length of oesophagus 3.703 mm. Vulva located nearly at junction of oesophagus and intestine 3.66 mm., distant from posterior tip of body. Anus terminal. Eggs barrel-shaped, slightly striated longitudinally with opercular plugs at the poles; their length 0.052–0.056 mm. and width 0.024–0.028 mm.

Differential diagnosis. Up to now no specimens of *Trichocephalus* have been found in *Sorex araneus* and in Insectivora in general. Only one species of the genus *Capillaria* Zeder, 1800, *C. incrassatum* Diesing, 1851, was registered in *Sorex tetragenurus* Herm. but its description is very incomplete. In the work of Stossich (Jl. genere Trichosoma Rudolphi, Trieste, 1890) the following description is given for *Tricho-*

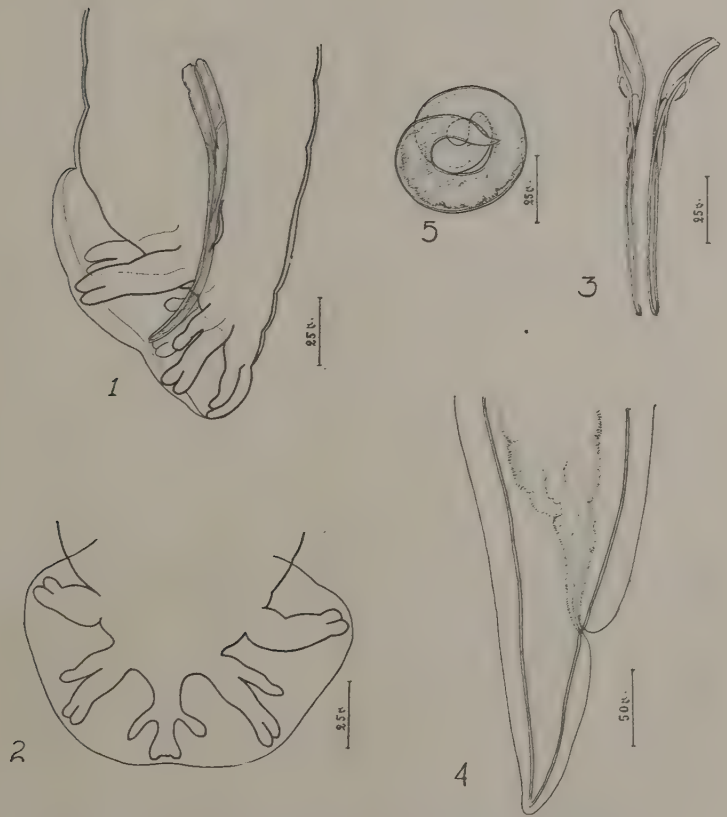

Figure 1. *Crenosoma skrjabini*, n. sp., male, caudal end, lateral view.
Figure 2. *Crenosoma skrjabini*, n. sp., male, bursa with the rays.
Figure 3. *Crenosome skrjabini*, n. sp., male, spicules.
Figure 4. *Crenosoma skrjabini*, n. sp., female, caudal end.
Figure 5. Larvae of *Crenosoma skrijabini*, n. sp.

soma incrassatum: "Mas. 10.4 mm.; Fem. 14.2 mm. Corpo posteriomente ingrossato a superficle quasiliscia; estremita caudala del maschio troncata obliquamente, della femina rotundata; guaina del cirro inerme, striata di traverso. Ova lunghe 0.065 mm., e large 0.025 mm." Given that *Sorex tetragonurus* is found in the Alps regions of France, Italy, Austria and Germany and that *Trichosoma incrassatum* is said to present a transversal striation of the sheath of the spicule whereas in *T. busuluk,* here described, the sheath is furnished with spines, we think that these two species cannot be identified. From all the other forms of *Trichocephalus Schrank,* 1788, *T. busuluk* differs by its small dimensions and by the markedly feeble expansion of the posterior part of its body which features approach those of the genus *Capillaria.*

Suborder Ascaridata Skrjabin, 1915.
Family Heterocheilidae Railliet et Henry, 1915.
Subfamily Anisakinae Railliet et Henry, 1912.
Porrocoecum sp. (larvae).

In a shrew-mouse were found 82 larvae of *Porrocoecum,* 75 under the skin and in the muscles, five in the liver, and two in the spleen. All the larvae were enclosed in a nearly colorless and transparent cyst through which, spirally rolled, they seemed colored a green or yellow-green.

Description. When taken from cyst larvae appeared of whitish hue with intestine a vivid green or yellow-green color; extremities of body less intensely colored. Deep striations of cuticle divided in middle portion of body by intervals of 0.0366 mm. become markedly less evident toward both extremities and their intervals diminish to 0.0032 mm. at posterior end; in the anterior region about 0.0817 mm. from tip, striations almost disappear. Length of body 14.75 to 19.28 mm., maximal width 0.457 mm.; at end of oesophagus 0.329 mm. and at anus 0.062 mm. Length of oesophagus 1.207 mm., width 0.073 mm. Intestine, with maximal width 0.219 mm., presenting on its whole length a series of enlargements. At junction with oesophagus, intestine forced aside toward anterior extremity of body and for the space of 0.219 mm. runs parallel to oesophagus. Distance from tip of tail to end of intestine 0.293 mm. Anus on ventral surface at 0.147 mm. from tip of tail; tip of tail with conical spine 0.32 mm. long and 0.013 mm. wide at the base.

I wish to express here my gratitude to Professor Skrjabin under whom the present investigation has been carried out and I would also acknowledge my indebtedness to Dr. A. Petrov and Dr. I. Orlov for their help.

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A NEW HARMOSTOME ADOLESCARIA FROM *CAMPELOMA DECISUM* SAY

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During April and May, 1933, large numbers of a gastropod, *Campeloma decisum* Say, were collected at Constantia, N. Y., from a pond formed by a dam across Frederick Creek, and serving as a reservoir for the operations of the State Fish Hatchery. All of the snails collected proved to be females,[1] and were found to be 100 per cent infested with a larval trematode belonging to the Harmostomidae.

This larva was in the adolescaria stage, and lay packed in large numbers in the uterus of the snail. The worms were especially abundant in the proximal portion of the uterus, but were also numerous in the lower portion of the tube where they found lodgement between the developing young. They were both free in the lumen and attached to the wall by means of their suckers, and not surrounded by a cyst. Depending upon the size of the host from 100 to 400 worms occurred in a single snail. In other species of this group the transfer of the adolescaria from the snail to the final host is accomplished when the latter eats the former. If this method of transfer applies in the present case then the final host must be some bird or mammal that occasionally feeds upon Campeloma.

The worms are slow moving but very muscular, and have considerable powers of extension and contraction. For the most part when undisturbed they lie motionless at nearly full length upon the bottom of a dish of tap water. In life the larva is of a ruddy color. Seen in mass through the translucent walls of the oviduct they impart a salmon pink tinge to the organ.

Description of *Cercariaeum constantiae* n. sp. (Pl. I, Figs. 1–7.)

Length 1.3 mm., width 0.4 mm. at level of acetabulum. Body flattened, not over 0.1 mm. thick, except over suckers. Suckers comparatively large and powerful. Oral sucker 0.150 mm. in diameter, opening ventrad. Pharynx about 0.070 mm. in diameter. Oral and ventral suckers both spherical. Ventral sucker about 0.230 mm. in diameter, with muscular wall measuring 0.050 mm. in thickness. Skin rugose, with numerous anastomosing thin edged transverse folds forming a network over entire surface of body. A number of wart-like cuticular bosses in head region, especially abundant around lip of oral sucker. Spines entirely lacking. Excretory bladder at posterior tip, pore terminal, siphons passing anteriad external to crura. Excretory bladder and basal part of siphons perform rhythmic contractions about once in seven seconds. Siphons tortuous, extending forward

[1] Dr. Frank C. Baker informs me in a private communication that this experience is general in collecting Campeloma; that females predominate, and that males are rare.

to level of intestinal bifurcation, where they are thrown into several loose coils, and then pass backward again, as "flammiferous tubes." Flammiferous tubes divide near anterior edge of acetabulum into anterior and posterior branch. Flames lacking in the two branches arising from flammiferous tube. Flames of flammiferous tubes about three times as large as flame cells of worm and their cilia set in a flat row instead of forming a conical point. Number of flames uncertain, if constant; 24 to 26 per side counted in different individuals. Crura fairly straight passing to short distance posterior to acetabulum; filled with masses of small, spherical, refractile granules. Genital primordia in caudal region. Testes lateral, elongate; ovary pear shaped, slightly anterior to testes on right. Uterus a delicate coiled tube between ends of intestinal crura, with anterior and posterior limits marked by acetabulum and gonads; best traced in living specimens. In stained preparations its thin wall surrounded by a thick layer of chromophilic cells. Yolk ducts descending on either side of body, uniting in transverse duct. Common yolk duct passes forward near median line. Vitellaria as yet indistinguishable. Character of oötype uncertain because of incomplete differentiation of reproductive organs. Laurer's canal visible as a chain of cells descending from ovary, passing posteriad a short distance, and to the surface. Genital pore ventral, between testes, slightly to left of median line; at this stage a mere invagination of cuticula. Cirrus sac as yet completely undeveloped.

Host.—*Campeloma decisum* Say.

Location.—Uterus.

Locality.—Constantia, New York.

Cotypes.—U. S. N. M. No. 32544.

DISCUSSION

Parthenitae or cercariae could not be found although a great many snails were examined. This was taken to indicate that these stages had been completed earlier in the season, so that only the adolescaria were present at the time of examination. The cercariae of the Harmostomidae are characterized by the absence of a natatory tail, absence of a stylet and stylet glands, and the small number of cercariae simultaneously produced by a parthenita. Furthermore the cercariae pass their adolescence in the same snail in which they have been developed. Most of the Harmostomidae whose life cycles are known develop in land snails, which perhaps accounts for the character of the cercaria and life history. Sinitsin is of the opinion that the cercaria gains its final position by leaving the body of the snail after the fashion of other cercariae, crawling about in the mantle cavity, and entering the organ constituting its final abode through its external opening. All of the known Harmostome adolescaria have been found either in the kidney, the peridardium, or the salivary gland of the host. In the present species the adolescaria are found in a new location, the uterus. This location is quite consistent with Sinitsin's theory, since the cercariae crawling about in the mantle cavity of the snail could easily enter the uterus by way of its papillose orifice.

No other Harmostome has been found in a Campeloma. Most of the Harmostominae reported are from pulmonate snails. Sewell, 1922, reported a Harmostome from Vivipara, but this is an Indian form. No other Harmostome has been reported from the Viviparidae. Sinitsin,

1931, states, "So far as my experience goes the location of the adolescariae in the snail host may be considered as a specific if not a generic character," and further goes on to say, "the parthenita of a definite species (of Harmostome) can develop only in one definite species of snail." Hence the present species is set off sharply from other species, not only by its location in the snail host, but by the species of the host.

The final host of this species is doubtless some bird or mammal feeding upon the Campeloma. Attempts thus far to discover the final host among the animals associated with the pond have been unsuccessful.

Following Sinitsin's classification, the species belongs in the family Harmostomidae, subfamily Harmostominae, and tribe Ectosiphonea. However, it is in violation of the family definition in that the flammiferous tubes do not extend into the posterior region. Sinitsin states that the flammiferous tube passes backward to the level of the bladder and then turns anteriorly and gives rise to the non-ciliated system of vessels. This condition, however, is modified in the present species, for the flammiferous tube extends back only to the level of the anterior border of the acetabulum. And whereas Sinitsin states that the Harmostominae develop in Pulmonata, this species develops in a gilled snail. Furthermore, it violates the definition of the Ectosiphonea in that the yolk reservoir is posterior to the ovary, and not dorsal to it, the ovary itself being very close to the dorsal surface of the body. Finally, the testes are lateral instead of tandem or oblique as in other forms. Nor can this species be classified any better on the basis of the system of Witenberg, 1925. In view of these discrepancies the present species will not fit into any recognized genus. However, it remains to be seen whether these differences are real, or only apparent because of the incomplete development of the adolescaria.

It is hoped that further search and experiment will yield the adult worm in the final host, so that a clearer understanding of the species can be obtained. Until the adult worm has been recognized it is unwise to create a new genus for the form. Nevertheless, it seems clear that a new species is represented. It is proposed that this form be known as *Cercariaeum constantiae* n. sp., from Constantia, the place of its discovery.

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Explanation of Plate I

Scale with Figure 6 applies to Figures 3 to 7, inc. Figures 1 and 2 freehand.

ABBREVIATIONS

ac—acetabulum.	eb—excretory bladder.	lc—Laurer's canal.	t—testes.
c—flame.	ft—flammiferous tube.	ov—ovary.	ut—uterus.
cr—crura.	gp—genital pore.	s—siphon.	yd—yolk duct.

Fig. 1. Ventral view of living worm under cover glass pressure, cuticular wrinkles indicated only in anterior region. Flames in flammiferous tubes show extent of these organs, but about ten have been omitted on each side.

Fig. 2. Portion of flammiferous tube, showing brush like arrangement of cilia in the flames.

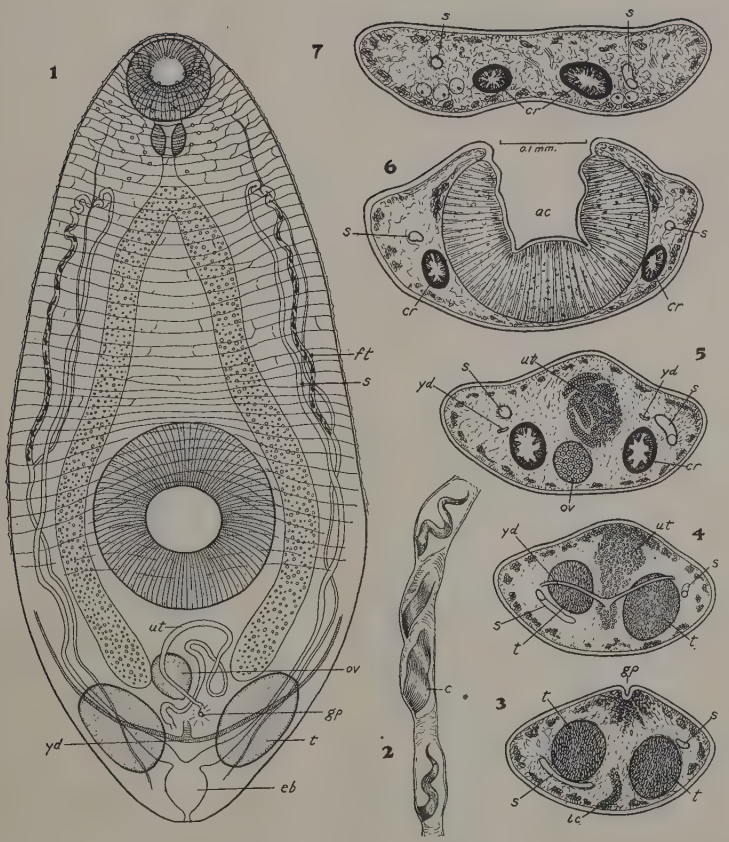
Fig. 3. Composite of three contiguous sections (10 microns thickness) at level of, and posterior to genital pore. Camera lucida.

Fig. 4. Composite of three sections immediately anterior to Figure 3. Yolk ducts pass over anterior surfaces of testes.

Fig. 5. Section through level of ovary. Cells of uterine primordium show little differentiation.

Fig. 6. Section through the acetabulum, showing position of crura and siphons.

Fig. 7. Section through pre-acetabular region. All sections Figs. 3 to 7 from same series.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THE TAXONOMY AND EARLY DEVELOPMENT OF *PROCAMALLANUS FULVIDRACONIS* N. SP.

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I. INTRODUCTION

In working on the nematode collection of the Division of Parasitology, Department of Pathology, Peiping Union Medical College, the writer had the opportunity to study a new form of *Procamallanus,* which, being a species allied to *Camallanus elegans,* was found to pass through similar intermediate hosts, *Cyclops* species. It is interesting that the development of the present form, in so far as that development occurs within the body cavity of the *Cyclops,* follows a course very similar to that of *Dracunculus medinensis,* as observed by Leiper in 1907.

II. TAXONOMY

a. *Review of Genus Procamallanus*

The type species of this genus, *Procamallanus laeviconchus,* was originally recorded by Wedl (1862) as *Cucullanus laeviconchus* from *Synodontis shaal,* a Silurid fresh-water fish from Egypt. Railliet and Henry, (1915), placed this form in the genus *Camallanus.* Baylis, (1923), on study of specimens from *Bagrus bayad,* another Silurid fish in Egypt, came to the conclusion that they are the same species as described by Wedl in 1862, and on the morphological ground of the presence of an undivided buccal capsule and the absence of tridents, he created a new genus, *Procamallanus,* for the reception of the type species, with the inclusion of a new species *P. spiralis* Baylis, 1923.

In addition to the above mentioned two species, six other species have been recently added to this genus: *P. parasiluri* Fujita, 1927; *P. iheringi* Travassos, 1928; *P. inopinatus* Travassos, 1928; *P. rarus* Travassos, 1928; *P. xenopodis* Baylis, 1929, and *P. mehrii* Agarwal, 1930. A review of the characters as described in the eight species as well as that of *P. fulvidraconis* n. sp., described in this paper, seems to justify an amendment of the generic diagnosis as follows:

Generic Diagnosis. Camallanidae: Buccal capsule undivided, wall of the capsule smooth or provided with spiral thickenings, tridents absent, oesophagus sharply divided into an anterior muscular and a posterior glandular portion. Male: caudal alae present, caudal papillae variable in number, spicules equal, subequal or unequal and dissimilar. Female: posterior end conical or provided with three or seven short processes, vulva either anterior or posterior to middle of body, the posterior branch of the uteri ending blindly without an ovary, viviparous.

TABLE 1.—*Details of Measurements of Species of Procamallanus*
(All measurements in mm.)

Species / Structures	*P. laeviconchus* Wedl, 1862		*P. spiralis* Baylis, 1923		*P. parasiluri* Fujita, 1927		*P. iheringi* Travassos, 1928		*P. inopinatus* Travassos, 1928		*P. rarus* Travassos, 1928		*P. xenopodis* Baylis, 1929		*P. mehrii* Agarwal, 1930	
	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
Body length	3.65	15.5	7	22.25	Unknown	6.0 (Immature)	12	16–21	5.12	16–30	5.30	Unknown	1.06–1.37 (Immature)	0.74–0.78 (Immature)	16–19	33
Buccal capsule — length	0.0675–0.070		0.07	0.09		0.12	0.072–0.080	0.088–0.096			0.072		0.08–0.10	0.07–0.075	0.17	0.35
Buccal capsule — width	0.0425–0.060					0.07	0.056–0.064	0.072–0.080	0.09	0.12	0.056				0.17	0.20
Oesophagus — muscular	0.4	0.47	0.38	0.49		0.43 (whole)	0.31 –0.37	0.41 –0.45	0.36	0.45	0.68		0.18–0.20	0.15–0.165	0.92–1.14	1.61
Oesophagus — glandular	0.6	0.78	0.33	0.52			0.74	0.80 –0.84	0.56	0.76	0.64		0.20	0.14–0.15	0.80–1.02	1.41
Spicules — left	0.05		0.1 ±				0.24 –0.25		0.12 (Sub-equal)		0.17		Shorter		0.255	
Spicules — right	0.15		0.15				0.52 –0.53				0.40		0.10–0.11		(equal)	
Vulva to — ant. end		7.0		9.25		4.0		Middle of body		Middle of body				0.37–0.43		23.0
Vulva to — post. end		8.5		13.00		2.0								0.31–0.41		10.0
Tail	0.037	0.15	0.14 (Scale)	0.16		0.12	0.10 –0.12	0.16 –0.24	0.20	0.20	0.12		0.03	0.04–0.05	0.102	0.23

Important measurements of the other eight species of the genus *Procamallanus* are compiled in the table 1.

b. *Description of Procamallanus fulvidraconis* n. sp.

Procamallanus fulvidraconis n. sp.

(Pl. I, Figs. 1, 3–6)

Specific Diagnosis—Procamallanus: Vulva of female at beginning of posterior fifth. Spicules of male very dissimilar and unequal: right spicule slender and relatively long; left one very broad and short resembling a gubernaculum.

Host: Pseudobagrus fulvidraco.
Location: Oesophagus and stomach.
Locality: Peiping, China.
Material: Five mature females and numerous males.
Specimens: Helminthological collection, P. U. M. C., Peiping, China. Pei No. 135.

Male: Number of specimens measured	5	
Body length	3.950–5.350	mm.
Body width	0.050–0.100	mm.
Buccal capsule	0.040–0.050 × 0.070–0.075	mm.
Nerve ring to anterior end	0.135–0.160	mm.
Excretory pore to anterior end	0.270–0.280	mm.
Oesophagus: Muscular portion	0.320–0.340	mm.
Glandular portion	0.360–0.430	mm.
Spicules: Left	0.025–0.032	mm.
Right	0.180–0.240	mm.
Tail	0.040–0.055	mm.

Female: Number of specimens measured	5	
Body length	9.800–12.250	mm.
Body width	0.150– 0.180	mm.
Buccal capsule	0.050–0.055 × 0.080– 0.090	mm.
Nerve ring to anterior end	0.165– 0.175	mm.
Excretory pore to anterior end	0.300– 0.330	mm.
Oesophagus: Muscular portion	0.400– 0.410	mm.
Glandular portion	0.420– 0.430	mm.
Vulva to posterior end	2.200– 2.600	mm.
Tail	0.110– 0.120	mm.

Anterior end truncate; mouth opening round and encircled by six minute labial papillae, four submedian papillae and the amphids. Buccal capsule barrel-shaped; wall of capsule provided with interrupted spiral thickenings; oesophagus sharply divided into anterior muscular and slightly longer posterior glandular portion. Cuticle thick and coarsely striated.

Male: Tail slightly coiled ventrad; muscles at coiled portion well developed, resembling a preanal pseudosucker. Caudal alae symmetrical, supported by nine pairs of preanal, and five pairs of postanal pedunculated papillae. Spicules very unequal and dissimilar; at first glance the short spicule may be taken as a gubernaculum; but we consider it as the short spicule on the ground that (1), it is provided with controlling muscles similar to that of the long spicule, (2), the long spicule takes a decidedly lateral position instead of a central one, and, (3), all other species of the genus are provided with two spicules and no gubernaculum. Right spicule relatively long and slender; left one heart-shaped on ventral view, much more weakly chitinized, very broad at the anterior margin, but also ends in a sharp point.

Female: Vulva at about beginning of posterior fifth of body; uteri divergent, posterior branch ending blindly without an ovary; viviparous. Tail conical, ending in three short blunt processes.

The characters of the spicules of the different species of the genus *Procamallanus* are found to be widely variable. With the exception of *P. parasiluri,* of which the male is unknown, the spicules are described as equal in *P. mehrii,* subequal in *P. inopinatus,* unequal but similar in *P. laeviconchus, P. spiralis, P. iheringi, P. rarus* and *P. xenopodis,* and very unequal and dissimilar in the present species *P. fulvidraconis* n. sp. In the female the posterior ends of *P. spiralis, P. iheringi, P. inopinatus* and *P. mehrii* all end conically without any processes. In the present species the posterior end of the female terminates in three short processes, a characteristic also shared by *P. laeviconchus* and *P. parasiluri;* while in *P. xenopodis* the posterior end of female is provided with seven processes. The vulva of the present species is also far posterior in position to those described for the other species.

III. DEVELOPMENT OF LARVAE

The development of the larvae from the penetration into the body cavity of the cyclops to the quiescent stage after the first moult was very remarkable. The first moult took place on the eighth or ninth day after infection under laboratory temperature. Repeated examinations extending over a period of five weeks failed to detect any other moult.

The Embryo. As in *Camallanus,* the females of the genus *Procamallanus* are all viviparous. The anterior end of the larva was provided with a dorsal spine, which was observed as a useful apparatus for penetrating the intestinal wall of the cyclops. The oesophageal wall was very thin; the three nuclei of the oesophageal glands were already seen at its base. The nucleus of the renette cell was situated at the anterior third of the intestine. The intestine was scantily filled with very fine granules, chiefly accumulated at the posterior portion. The rectal glands were already well developed. The rectal wall was represented by a fine slit. The genital primordium was at the one-celled stage and was situated posterior to the middle of the body. The tail was long and attenuated. The cuticle was conspicuously marked with transverse striations.

Cuticle. The cuticle of a newly discharged larva was relatively thin and coarsely striated. The only change which it underwent during the first stage was an increase in thickness as the larva grew in size. The cuticle after the first moult was very thick and markedly striated.

Buccal capsule. During this period of development the buccal capsule underwent a profound change; in the newly discharged larva there appeared no definite cavity. The anterior end was armed with a dorsal

spine, which was lost at about the fifth day, when a small but definite buccal capsule was developed. At about the eighth or ninth day, just before the first moult, the capsule assumed an elongated form with a rather narrow lumen (Fig. 9). When such a larva was observed under the slight pressure of a cover glass, the inner lining of the capsule was cast off together with the cuticle, and the buccal capsule immediately expanded to a form very similar to that of the adult, except that its inner wall was smooth, wthout any thickenings (Fig. 7).

Nerve ring. In the newly discharged larva the nerve ring was situated at about the middle of the oesophagus; as the glandular portion of the oesophagus developed, its position was consequently shifted forward, until, after the first moult, it occupied a position at the anterior sixth of the whole oesophagus. Detailed structures of the nervous system are difficult to make out in the living specimens.

Excretory pore. The excretory pore was first situated posterior to the middle of the oesophagus. With the development of the posterior glandular portion of the oesophagus, its position was shifted relatively anterior to the middle of the oesophagus. Leading from the ampulla posteriad there is a long duct which ends in a large club-shaped cell with a large nucleus; this corresponds to the "renette cell" of the free living nematode *Oncholaimus pristiurus* as observed by Chitwood (1931). The nucleus of this cell was found at the anterior third of the intestine in the newly discharged larva, but with the development of the latter, it was shifted relatively anteriad until it occupied a position just in the middle of the posterior part of the oesophagus in the fully mature larva.

Oesophagus. During this period the changes in the oesophagus were remarkable. In the newly liberated larva, the wall of the oesophagus was very thin, especially towards the anterior end, with a very broad lumen. After two or three days in the body cavity of the cyclops, the oesophageal wall became much thickened and its lumen correspondingly narrowed. The separation of the oesophagus into two parts took place near the time of the first moult, after which it possessed a clearly divided anterior muscular and posterior glandular portion. The whole oesophagus was increased to more than three times its original length in the course of three weeks.

Intestine. The changes in the structure of the intestine as well as in its contents were striking: the cells of the intestinal wall became thickened, also increased in number and became loaded with pigment granules. The intestinal content of newly liberated larva consists only of very fine granules; after being in the body cavity of cyclops for two or three days, its intestine was gradually filled with irregularly shaped yellowish content (Fig. 10). This intestinal content kept on increasing as the larva grew until during or immediately after the first moult when

the whole intestinal content was emptied all at once, thenceforth the intestine contained very little or practically no solid matter. The brownish color of the intestine which appeared after the first moult was due to the accumulation of numerous pigment granules arranged around the nuclei of the intestinal cells.

Germinal Primordium. In the newly discharged larvae, the germinal primordium was at the one-celled stage situated posterior to the middle of the body. At about the sixth day it changed to the four-celled stage; at the fourteenth day it consisted of more than ten cells and from that time there appeared to be not much development.

Tail. As the larva grew, the slender tail gradually retreated, leaving an empty sheath behind, until just before the first moult a short tripod tail, similar to that of the female adult, was found already formed within the old cuticle (Fig. 10).

TABLE 2.—*Growth of Larvae in Body Cavity of Cyclops (All measurements in mm.)*

Structures	Number of Days					
	0	3	6	10	14	21
Body length	0.455	0.592	0.690	0.733	0.756	1.015
Body width	0.030	0.035	0.036	0.040	0.037	0.044
Nerve ring to anterior end	0.040	0.050	0.073	0.075	0.072	0.088
Excretory pore to anterior end	0.058	0.065	0.102	0.117	0.125	0.146
Oesophagus	0.092	0.105	0.150	0.282 (2 parts)	0.275 (2 parts)	0.320 (2 parts)
Intestine	0.210	0.310	0.412	0.400	0.422	0.596
Tail	0.152	0.165	0.145	0.045	0.055	0.055

The above measurements were not obtained by following the growth of any single larva, but were composed from observations of different larvae at different stages in the various species of *Cyclops*. The first moult took place between the eighth and the tenth day.

IV. INFECTION EXPERIMENTS AND OBSERVATIONS

a. *Infection of Cyclops*

Feeding experiments with Cyclops. Out of the ten species of *Cyclops* found in the ponds of Peiping, the following seven species were used for experiments: *Cyclops albidus, C. bicuspidatus, C. magnus, C. phaleratus, C. serratus, C. tenuis* and *C. vicinus.*

Ingestion of Larvae by the Cyclops. In strong contrast to the activity of the miracidia of Trematodes in swarming around and invading their specific mollusc hosts, and in contrast also to the activity of the oncospheres of *Diphyllobothrium* in swimming about to meet the cyclops, the entrance of the larvae of the present species into the intermediate host was effectd in an entirely passive manner. The larva, with its intermittent movements of coiling and uncoiling, remained otherwise com-

paratively quiet at the bottom of the water. Its only action to induce the cyclops to ingestion was to loop around one of the latter's appendages —a phenomenon also observed by Leiper (1907) in his study of the larvae of the Guinea worm. The different species of cyclops readily ingested the larvae *per os* when they happened to come across them.

TABLE 3.—*Feeding Experiments to Find out the Percentage of Infection of Each Species of Cyclops and the Percentage of Larvae Successful in Penetrating into the Body Cavity of the Different Species of Cyclops*

Lot 1

Species	Positive	Negative	Percentage of Infection
C. albidus	0	7	0
C. bicuspidatus	0	3	0
C. magnus	1 (2)*	7	12.5
C. serratus	2 (1)	25	7.4
C. vicinus	2 (1), 2 (2)	11	26.7

Total number of larvae ingested 120
Total number of larvae recovered in body cavity of *Cyclops* 10
Percentage of larvae successful in getting into the body cavity 8.3

* Figures in brackets denote the number of larvae found in the body cavity of each infected cyclops.

Lot 2

Species	Positive	Negative	Percentage of Infection
C. albidus	0	4	0
C. magnus	0	1	0
C. phaleratus	0	4	0
C. tenuis	0	1	0
C. serratus	25 (1), 4 (2)	30	49.2
C. vicinus	3 (1), 2 (2)	21	19.2

Total number of larvae ingested 300
Total number of larvae recovered in body cavity 40
Percentage of larvae successful in getting into the body cavity 13.3

From the results as shown in Table 3, the following conclusions were drawn:

1. Out of the seven species of *Cyclops* used for the feeding experiments, three species proved to be positive.

2. Of the three susceptible species, the percentage of infection is highest in *C. serratus,* medium in *C. vicinus* and lowest in *C. magnus.*

3. The number of larvae successful in getting into the body cavity after ingestion ranges from 8.3 to 13.3 per cent.

In the case of *C. magnus* only the young adults were susceptible, while the fully mature ones usually escaped infection. It is interesting

to point out in this respect that a similar observation had been made by the writer in an infection experiment with the oncospheres of *Diphyllobothrium decipiens* and *D. erinacei* to the same species of *Cyclops*. Perhaps the intestinal wall of the fully mature forms of *C. magnus* is more resistant to the parasites than that of the young forms.

Injury to the Cyclops. The presence of larval stages of *Diphyllobothrium* and *Dracunculus* in the cyclops has often been regarded by different authors as having no effect on the host. On the other hand the presence of parasitic nematodes in the body cavity of different insects has been stated as having a profound effect on the host in some cases, and practically no effect in others. The writer's observation in the present case showed that the cyclops were definitely affected, especially in the development of the genital system. Observations regarding this subject may be described in detail in a later paper.

b. *Activities of Larvae*

Liberation of Larvae. When a living, sexually mature female was observed in normal saline, the uteri showed intermittent movements, by which the uterine contents were thrown back and forth. Twenty movements were observed in the space of two and a half minutes. The larvae had a strong tendency to move cephalad, and crowded at the anterior end of the uterine tube; while the movements of the uteri often tended to throw them back. Both movements are important in liberating the larvae, for the vaginal tube starting from the uteri runs anteriorward and it is therefore only by moving it in the same direction that the larvae within the vaginal tube can find their way out; on the other side the vaginal tube opens into the uteri at the posterior fifth of the body, the larvae which are still in the uteri must therefore be thrown posteriorward to this opening in order to get entrance into the vaginal tube.

When the contraction movement of the uteri passed forward, the opening connecting the vaginal tube and the uteri was distended with uterine fluid and a larva which happened to be in the right position and was thrown into the opening with its head end directed anteriad could then actively force its way out through the narrow lumen of the vaginal tube in about two minutes' time; a larva thrown in with its posterior end forward, was apt to be thrown back again by the next movement of the uteri. The liberation of any larva from the uteri seemed to depend on the coincidence of three factors: (1) the position of the larva, (2) the direction of the movement of the larva and (3) the movement of the uterine tubes. When observed in normal saline seven larvae were seen liberated in the time of about half an hour.

Movement of Larvae in Water. When a larva got out of the vulva, the tip of its long slender tail often stuck at the lips of the vulva; it then

exhibited a sort of swinging movement in order to break away from the entanglement. Similar movements were made when the tail got entangled with a small particle in water. When the larva was lying free in water, its movements consisted of coiling and uncoiling at more or less regular intervals. The movements were not strong enough to maintain the body weight of the larvae against gravity, so they always remained at the bottom of the water. In tap water and under laboratory temperature, the larvae lived about a day.

Penetration of Intestinal Wall of Cyclops. The cyclops swallowed the larvae readily when they happened to come across them. When ingested, the larvae moved freely along the whole digestive tract. The digestive juice of the host had no effect on the larvae, nor did the intestinal content present any hindrance. The movement inside the intestine of the cyclops was very characteristic. The larva first coiled itself dorsally as far as it could go and then with a sudden springing action, the anterior portion was stretched and struck on the intestinal wall of the cyclops. The sharp dorsal spine on the anterior end now proved to be a very efficient apparatus against the soft wall of the intestine of the cyclops. With intermittent rest the larva carried on such movement for hours and at the same time changed its position in the intestine, until it finally hit on a weak point, broke through and got into the body cavity in a few seconds. The shortest interval observed between ingestion of larvae and penetration of intestinal wall was about three hours.

Injury to the Larvae by Ingestion. Compared with the oncospheres of the *Diphyllobothrium,* which are protected by a cilliated coat, the larvae of the present form with their relatively large size and elongated shape, seemed to stand a much greater chance of being injured during the act of ingestion by *Cyclops.* Fragments of injured larvae were frequently observed. In one case a *Cyclops serratus,* which had taken a heavy meal of the larvae, was observed under the slight pressure of a cover glass. Seven ingested larvae were seen being vomitted out through the mouth, of which only two were still alive; the others were either dead or merely fragments of dead larvae. The mortality during the act of ingestion by the cyclops appeared to be very high.

Activity and Quiescence inside the Body Cavity of the Cyclops. When the larvae reached the body cavity of the cyclops they began a sort of stretching movement. They often pressed their anterior ends between the musculature, especially near the region of the eye-spot. A small strand of host tissue was once seen in the mouth cavity of a mature larva, but actual swallowing of the tissue has not been observed. On the other hand the colored granules usually present in the body cavity of the cyclops were found twice in the intestine of immature larvae of five to

six days old. The positions of the larvae inside the body cavity changed very often and the activity was continued until shortly after the first moult, they then coiled up and from that time remained quiescent. It now seemed that the metamorphosis of the parasite inside the cyclops was completed and that activity would be resumed only upon changes brought about by the death of the host.

Further Development. The further development of the parasite has not been traced, although it seems that a second intermediate host is not necessary. Worms collected from fish with natural infection, after being kept in laboratory for more than four months, were still not yet sexually mature. This shows that the development of larvae in the fish is a very slow process, and more moults must be passed in the definitive host. About thirty per cent of the larger fish, *Pseudobagrus fulvidraco* were found to be naturally infected in the Peiping region.

V. SUMMARY

1. Brief review of the genus *Procamallanus* and description of *P. fulvidraconis* n. sp.

2. The early development of *P. fulvidraconis* n. sp. in the intermediate host of *Cyclops*.

3. Out of seven species of *Cyclops* used for the infection experiments the three species, *C. magnus, C. serratus* and *C. vicinus* proved to be positive.

4. The embryos were passively ingested by the cyclops *per os,* but they actively penetrated the intestinal wall of the hosts by a peculiar coiling and stretching movement and with the aid of the sharp dorsal spine at the anterior end.

5. Development of larvae could be traced in all the three species of *Cyclops*. Under laboratory temperature only one moult was observed, between the eighth to the tenth day after infection; thenceforward the larvae became coiled up and remained quiescent in the body cavity of the cyclops until the death of the host.

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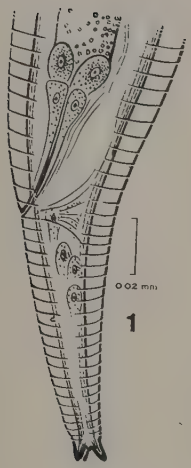
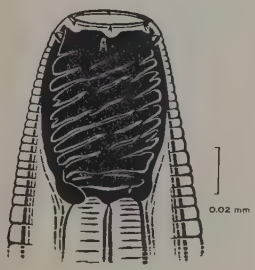
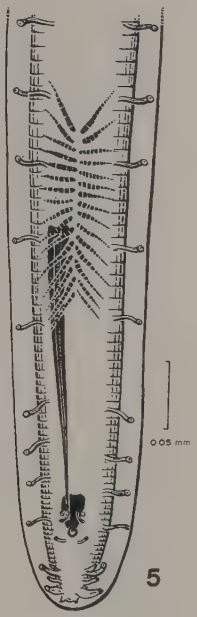
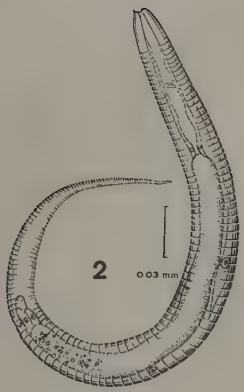
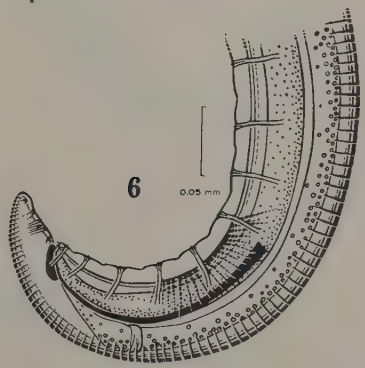
PLATE I











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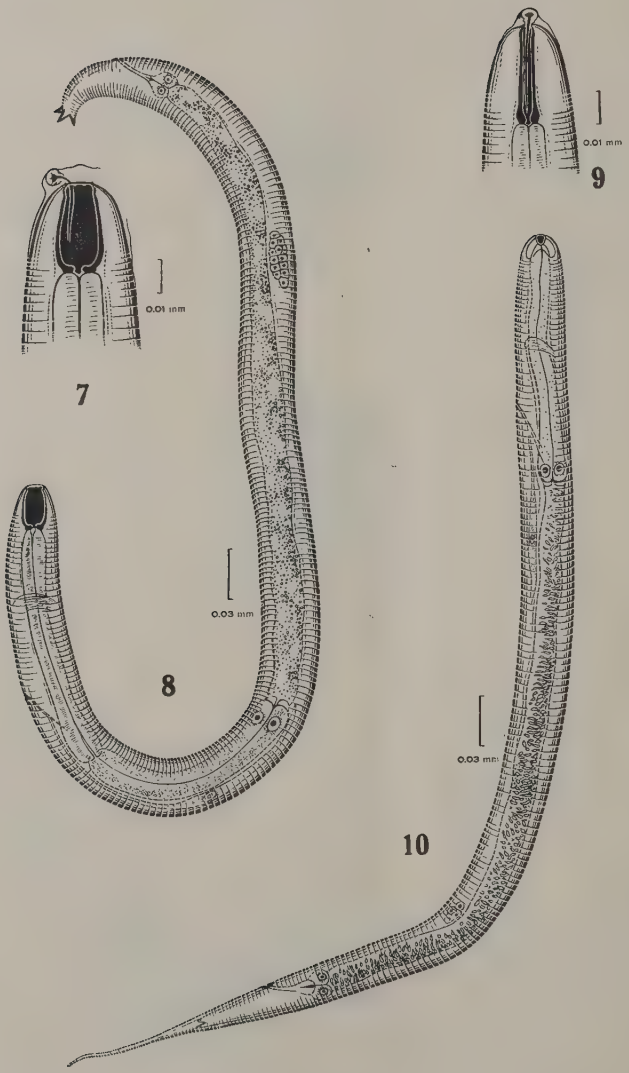

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Explanation of Plates

Plate I. *Procamollanus fulvidraconis* n. sp.
- Fig. 1. Posterior end of female, lateral view.
- Fig. 2. Mature embryo, lateral view.
- Fig. 3. Anterior end of female, frontal view.
- Fig. 4. Anterior end of female, lateral view.
- Fig. 5. Posterior end of male, ventral view.
- Fig. 6. Posterior end of male, lateral view.

Plate II. *Procamollanus fulvidraconis* n. sp.
- Fig. 7. Anterior end of larva just after the first moult. The buccal capsule was forced to expand under slight pressure of cover glass with the casting away of its old lining. (Compare Fig. 9).
- Fig. 8. Larva 14 days old (5 days after first moult) with well developed buccal capsule, differentiated oesophagus and tripod tail.
- Fig. 9. Anterior end of larva just before the first moult; the buccal capsule not yet expanded. (Compare Fig. 7).
- Fig. 10. Larva 6 days old with small buccal capsule, simple oesophagus and slender tail.

A *DIPHYLLOBOTHRIUM* FROM CATS AND DOGS IN THE SYRACUSE REGION

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On March 7, 1933, two cats from the Humane Society of the City of Syracuse were autopsied in this laboratory, and found infested with a species of Diphyllobothrium. One of these cats harbored a single worm, the other two. The smallest of these worms was about 20 cm. long, the largest 48 cm. Fifty additional cats from the same source were examined subsequently at different times up to the middle of June, but no more of the worms were discovered.

Since many Diphyllobothriids are conveyed to the final host by fish, further search for the worm was made in the vicinity of Oneida Lake, the chief fishing ground of this region, on the chance that fish from this source may have been the origin of the cat infestation. On May 13, a cat from the village of Cleveland, on the north shore of Oneida Lake, was autopsied, and found to harbor three specimens of the worm, the largest of which was about 60 cm. long. This cat had been raised in the village and was said by the owners to be very fond of raw fish. Another "tramp" cat of unknown habits from the same locality contained no worms. It proved unexpectedly difficult to secure more cats from the lake villages, the owners refusing to part with their pets.

On May 12, *Diphyllobothrium* eggs were found in the feces of a dog from the village of Constantia, on the north shore of Oneida Lake, and these proved very similar to the eggs of the cat Diphyllobothrium. The owner stated this dog had frequently been fed lawyers (*Lota maculosa*) taken while ice fishing, and that it was very fond of raw fish. Another dog, from the same farm, which was said to refuse raw fish, was found negative. On June 12, a month after discovery of the eggs, the infested dog was treated with arecoline, and passed about a dozen large specimens of a Taenioid cestode, but no *Diphyllobothrium,* and subsequent fecal examination showed no eggs. Apparently the *Diphyllobothrium* had been spontaneously lost during the interim. However, eggs had been collected from the original fecal sample, and their development was followed. The above collection of material forms the basis of this article. Only worms from the cat were available for morphological study, although from the above it appears that this same, or a closely similar species occurs in the dog. A description of the worm which is considered to be a new species follows.

Description of *Diphyllobothrium mansonoides* n. sp. (Figs. 1–20).*

Diagnosis. *Diphyllobothrium,* subgenus *Spirometra*: Maximum length of strobila 60 cm., maximum width of proglottids 7 mm. Margins serrate. Strobila delicate in neck region, fairly robust posteriorly. Stoutness of scolex varies in different specimens with maximum diameter from 0.2 mm. to almost 0.5 mm. Bothria rather uniformly about 1.0 mm. in length. Neck about 0.25 mm. wide immediately in back of scolex, and about 0.5 to 1.0 cm. long before segmentation begins. Genital primordia first appear 2.5 to 3.0 cm. back of scolex; Proglottids at this level about 0.8 mm. wide. Number of immature proglottids large, 200 to 300 or more. Mature proglottids with eggs occur 16 to 20 cm. posterior to scolex, and are from 3.0 to 5.0 mm. wide. Maximum width of ripe proglottids 7.0 mm. Mature proglottids broader than long; ratio about 1 to 4. At times this ratio may be altered in young specimens to 1 to 2; while rarely in terminal segments length may exceed width in ratio of 3 to 2. Preponderance of chains show proglottids markedly short and wide.

Scolex delicate, but little set off from neck. Cross section of scolex rectangular, width exceeding height. Bothria shallow, broad and flat bottomed, continuous with surface of neck. Excretory canals appear as two small lateral tubules.

Genital papilla in ripe proglottids in center of ventral surface, or somewhat anterior. Cirrus opens as a small pore, vagina immediately posterior as a transverse slit. Uterine pore about midway between vaginal pore and posterior edge of proglottid, slightly to one side of median line. Testes numerous, spherical, in lateral fields, converging anterior to the genital papilla, but not along posterior edge of proglottid. Located in median plane of proglottid, as seen in sections. External to testes a layer of longitudinal muscle bundles; external to these the vitellaria. Vitellaria numerous, extending around both surfaces of proglottid. Distribution similar to that of testes, frequently, though not always, meeting anterior to genital mass, but not posterior.

Vasa efferentia meet vas deferens in dorsal region at level of uterine pore. Vas deferens thrown into numerous lateral convolutions dorsal to the uterus; enters cirrus sac on its posterior aspect near dorsal tip of the organ, and proceeds through its muscular wall by short narrow duct, to communicate with seminal vesicle. Inverted cirrus forms a second chamber within cirrus sac, the two communicating by ejaculatory duct, which lies near the anterior surface of cirrus sac. Exserted cirrus has pointed tip. In this state only chamber within cirrus sac the seminal vesicle, and ejaculatory duct opens to exterior directly.

Female system consists of a short broad cavity, or vulva, ending blindly at about one-third depth of proglottid. Vagina opens into vulva about midway on its anterior wall, and from this point passes dorsad, and then posteriad, without lateral undulations, curving ventrally over surface of the uterine mass. Between outer and inner uterine coils it takes a sharp dip dorsad, and bends back again at an acute angle, and a little farther back its walls gradually expand to form the seminal receptacle. Seminal receptacle retort shaped, bent to one side of median line, bulbous end posteriad, on dorsal aspect of ovary. Ovary a flattened ventral band, with reticulate wings. Oviduct arises on median line from posterior edge of ovary; at its origin surrounded by a muscular sphincter and a circle of gland cells (the oöcapt). It passes posteriad and is shortly joined by a very narrow duct arising from posterior end of seminal receptacle.[1] Oviduct thence

* Additional material of this species was secured from a cat in Syracuse on March 14, 1935. This material indicates that the species may attain a length of 1 meter, and a maximum width of 8 mm. Recently the author secured a specimen of *D. mansoni* through the courtesy of Dr. Teunis Vergeer. Comparison of this worm with the present species shows that *D. mansonoides* is unquestionably a distinct form.

passes a short distance laterally, is joined by common yolk duct, and becomes confluent with oötype. Oötype surrounded by shell gland for a distance of about 0.025 mm. Cells of shell gland deeply staining, forming a compressed cluster, about 0.3 mm. in diameter, posterior to uterus. Their long necks pass inward radially, and contact with oötype along the short distance stated. Their contents appear as diverging streamers, and a deeply stained core of their secretion, taking hematoxylin dyes, is visible in lumen of oötype.

Uterus of two sections, a posterior series of narrow "inner," coils, and an anterior series of heavy, "outer," coils. Two regions joined by a narrow isthmus or duct, of sufficient calibre to contain only three or four eggs in a single cross section. Posterior coils thin walled, seven or eight in number. Uterus passes through isthmus to region of outer coils, along dorsal surface. Dorsal to outer uterine mass thin-walled, narrow uterine tube performs four or five loops, of minor amplitude, and completely hidden behind the posterior large loop of the anterior uterine mass, Text Figure 1. This concealed part of the uterus histologically identical with inner uterine coils. Finally the tube joins the posterior

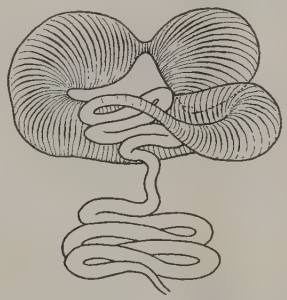

FIG. 1.—Dorsal view of the uterus showing its path, and division into a posterior and anterior series of coils. The heavy walled terminal segment of the uterus shaded.

large loop of the outer uterine mass, dorsally, and on the same side as the uterine pore. Terminal region of uterus consists of two transverse passages of large diameter, with thick glandular walls, containing numerous eggs with heavier shells than those in the inner uterine coils, and awaiting oviposition. Midway of the anterior transverse passage occurs a sharp constriction, or sphincter, dividing off a terminal globular compartment. The sphincter and terminal chamber possess well developed muscular walls which serve for the expulsion of eggs.

THE EGGS

The eggs of worms from the cat are 0.065 mm. long, by 0.037 mm. wide; variable in shape, with tendency toward pointed ends and conical operculum. When kept in tap water at room temperature, they showed the hooks of the oncosphere after nine days. At the end of 20 days the oncosphere and contents of the egg had withdrawn to the end opposite the operculum, and a single flame cell was visible in the oncosphere.

[1] Magath, 1929, in his description of *D. parvum* shows the connection of the oviduct and the seminal receptacle as a very wide passage equal to the full diameter of the latter organ. Such a condition certainly does not obtain in my material, where this duct is so narrow as almost to elude detection.

Thomas, 1930, found two flame cells in the oncosphere of *D. latum.* Although these eggs were followed up to the time of hatching, only a single flame cell could be found. Since this observation was made through the shell of the egg, it is possible that a second flame cell might have been overlooked. External to the coracidium a layer of droplets was visible just beneath the shell, and these had all receded away from the operculum, leaving a clear space at the end. On the 21st day the objective was lowered upon the cover glass, forcing the opercula off several of the eggs, so that the coracidia emerged. The long cilia, at first immobile, began to beat in about two minutes, and acquired maximum activity at the end of five minutes. These coracidia swam with such remarkable speed that they could not be followed with the microscope, which is in contrast to the slow wheeling motion of the coracidium of *D. latum.* The coracidium swims with the embryonic hooks to the rear. Although these artificially liberated coracidia were viable the eggs did not begin to hatch naturally until the 50th day, and were all hatched within the next five days.

The eggs from the dog were in general similar. Eggs from both sources were more pointed when first liberated, but after a period in culture they developed a fuller outline with more rounded ends. These eggs from the dog had not hatched at the end of 120 days. Otherwise the development and morphology of the contained embryo were similar. At the end of this period the embryos still appeared normal and ready to hatch, and their flame cells could be seen beating. Whether this difference in hatching time between eggs from the cat and the dog can be regarded as evidence that two different species are represented is problematical. Thomas, 1931, has shown that eggs of *D. latum* from the dog may require as long as 70 days for hatching, although ordinarily hatching within from 11 to 14 days. No further work was done to discover the first intermediate host.

DISCUSSION

Faust, Campbell, and Kellogg, 1929, have divided the genus Diphyllobothrium into two subgenera: (1) *Diphyllobothrium sensu stricto,* to include those members with rosetted outer uterine coils, and eggs with rounded ends, and (2) *Spirometra,* to include those members with spiralled outer uterine coils, and with pointed eggs. *D. latum* is an example of the first subgenus, while *D. mansoni* is a member of the latter. There is no question but that many of the numerous species of the genus *Diphyllobothrium* are of dubious standing. Many of the species named by the older authors are today unrecognizable because of inadequate descriptions.

The *Diphyllobothrium* from Syracuse cats cannot be recognized as any known species and is therefore considered to be a new species, *Diphyllobothrium mansonoides* n. sp. In having rather pointed eggs it falls within the subgenus *Spirometra,* and the outer uterine coils may be regarded as spiralled, in as much as they are not rosetted. In general features the worm is similar to *D. mansoni.* The adult *D. mansoni* was first described by Joyeux and Houdemer, 1928. These authors found three large coils in the anterior part of the uterus. Faust, Campbell, and Kellogg, 1929, restudied the type material, and figure the outer uterine mass as consisting of four and a half heavy coils as seen in ventral view, and this condition is definitely stated in their text. Neither of these authors takes into account the small thin walled coils of the uterus hidden behind the heavy coils of the outer uterine mass.

D. mansonoides differs from *D. mansoni* as follows. The bothria are different in that their free edges are poorly developed, whereas those of *D. mansoni* are flourishing, and the width of the scolex is only 0.2 to 0.5 mm. as against 0.4 to 0.8 mm. for *D. mansoni.* A cross section of the scolex in *D. mansoni* makes a square; in my material an oblong.

The nerve trunks of *D. mansoni* are considerably more lateral as figured by Joyeux and Houdemer, than they are in *D. mansonoides.* Calcareous corpuscles are abundant in *D. mansoni,* rare in my worm. The vagina of *D. mansoni* is laterally winding, but does not deviate from the median course in my material; furthermore the vagina of *D. mansoni* communicates directly with the exterior, without the terminal vestibule found in my species.

The uterus makes three large anterior loops in *D. mansoni,* according to Joyeux and Houdemer; four and one half according to Faust, Campbell, and Kellogg; and has no specialized terminal bulb. In *D. mansonoides* the uterus has only two large terminal loops, and a muscular terminal compartment set off by a sphincter. Since the anatomy of the uterus is absolutely constant in all my material there is no ground for assuming that this difference can be explained as variation.

The egg of *D. mansoni* hatches in 21 days (Okumura, 1919), that of my material in not less than 50.

Joyeux and Houdemer, 1928, have carefully separated *D. mansoni* from all other possibly related species. In reviewing these comparisons the same differences are found to separate the present species from other previously described forms. It is clearly set off from the members of the subgenus Spirometra considered by Faust, Campbell, and Kellogg, 1929, by character of the uterus and other features so apparent that they need not be reviewed here, coming close only to *D. mansoni.* It shows some resemblance to *D. ranarum* (from cats in the orient) but differs in shape of proglottids, and form and number of the outer uterine coils.

D. mansonoides differs from any species reported from the United States. It is definitely separated from *D. latum* and *D. cordatum* by scolex, neck, and uterus characters, and by its smaller size. The immature *D. americanum* of Hall and Wigdor, 1918, from the dog, is generally regarded as *D. latum,* and likewise *D. cordiceps* from the pelican (Skinker, 1932). *D. parvum* has also been shown by Magath, 1929, to be a synonym of *D. latum.* Material of *D. fuscum,* from a dog in New York City, and *D. pseudocordatum,* Wigdor, 1921, was obtained from the U. S. Bureau of Animal Industry, for comparison, and both these species are distinctly different from my material. The scolex of *D. pseudocordatum* is very massive, the bothria very short compared to the present worms, and the uterus definitely rosetted, with at least seven lateral loops in the outer mass. *D. fuscum* differs in the much greater length of the proglottids, and the uterus has at least fifteen lateral rosetted loops. Furthermore, in both these species, the genital papilla is almost at the extreme anterior edge of the proglottid, instead of near the middle. Dikmans, 1931, reported *D. mansoni* from a cat in Louisiana. This is the only published record of the adult worm in the United States. The larva has been reported once by Moore, 1914, found in a breast tumour.

In consequence of the above considerations it has appeared necessary to establish a new species to receive this form. It is possible that later comparative study may force this species into synonymy with some other form, but the evidence at present indicates that it is valid. I propose the name *Diphyllobothrium mansonoides* new species.

Host.—Cat.

Location.—Intestine.

Locality.—Syracuse and vicinity.

Type.—U. S. N. M. No. 32569.

The pike perch is the most sought after game fish of Oneida Lake. This fish is known in other regions to carry the plerocercoids of *D. latum.* On the chance that the plerocercoids of the present species might also occur in this fish 45 were carefully examined, but no plerocercoids were found. The infested dog was said to have been fed numerous *Lota,* caught by ice fishing. Possibly this fish carries the plerocercoids. However, *Lota* is not easily caught during the summer, and it was not possible to check on the flesh of this fish.

Frogs and snakes are known to serve as the host of the plerocercoids of *D. mansoni* in the orient. If this fact also applies in the life history of the present form, then the fish eating habits of the infested animals above referred to, are without significance in explaining these infestations.

From the comparative ease with which my material was collected, it would appear that this worm is fairly common in cats, and possibly also in dogs in the Syracuse area. I am indebted to Dr. G. R. La Rue for examining this manuscript, and for making certain constructive suggestions.

SUMMARY

1. A new species of *Diphyllobothrium* has been found in cats in the Syracuse region, and eggs similar to those of this species have also been found in fecal examination of a dog.

2. The worm belongs to the subgenus *Spirometra,* and stands close to *D. mansoni,* but differs in a number of critical details.

3. The eggs of the worm are of the *D. mansoni* type in size and shape, and those from the cat hatch in from 50 to 55 days. The oncosphere has a single flame cell.

4. In view of its general similarity to *D. mansoni* the form is named *D. mansonoides* n. sp.

5. Infested animals occur on the shores of Oneida Lake, and there is a small amount of circumstantial evidence that fish, possibly the ling, convey the plerocercoids.

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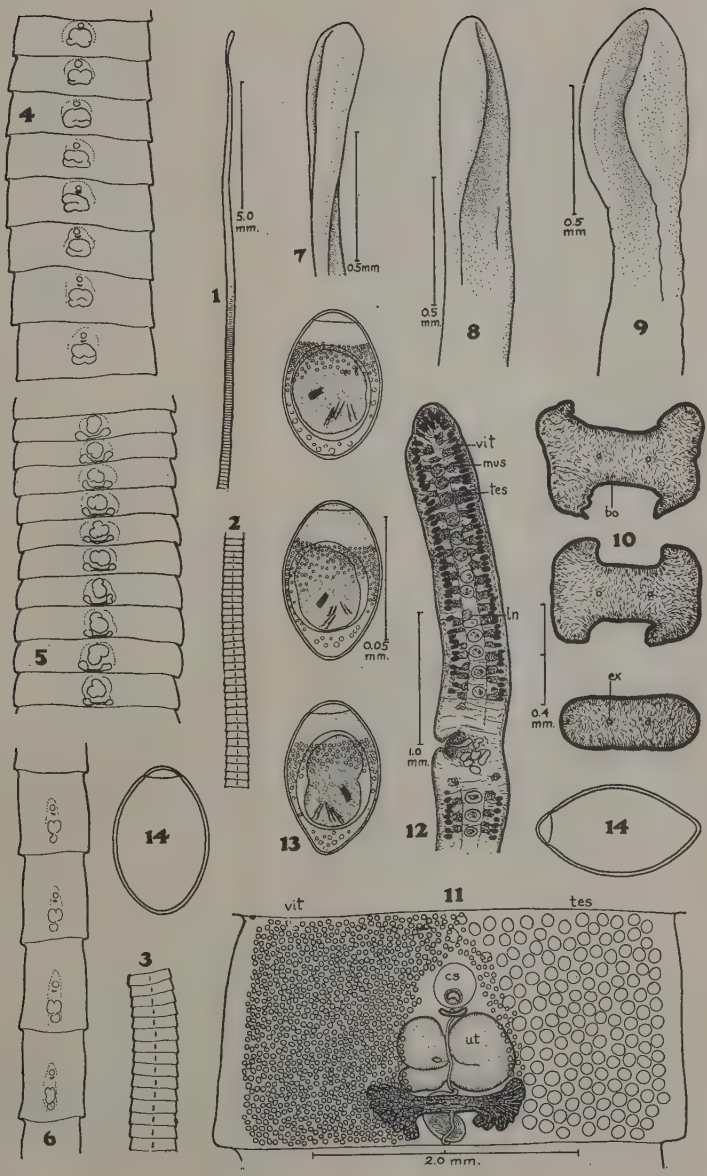
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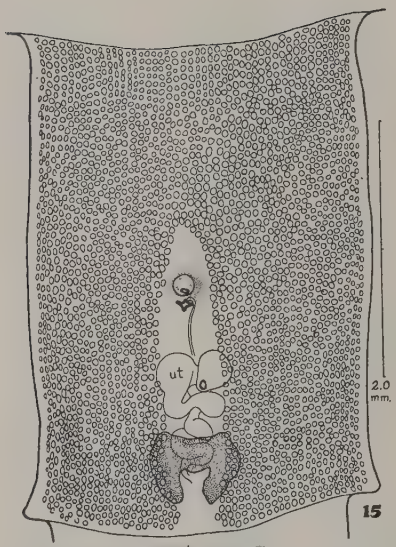
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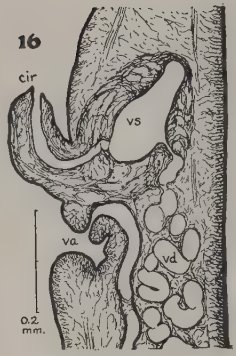
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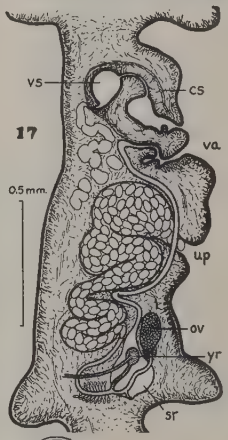
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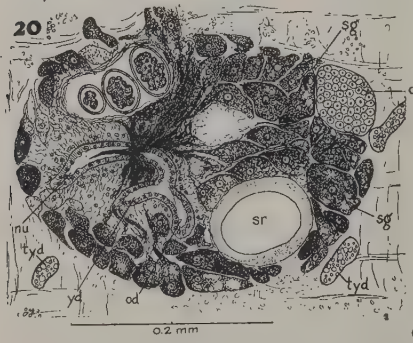
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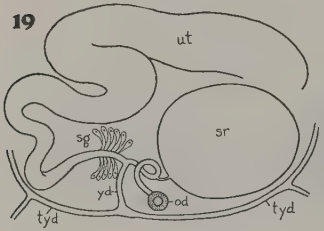
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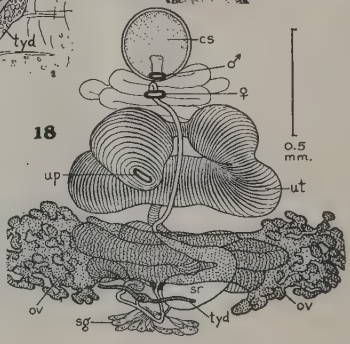
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♀
0.5 mm.
18
up
ut
sr
ov
sg
tyd
ov

Explanation of Figures

abbreviations

bo,	bothria.	sr,	seminal receptacle.
cir,	cirrus.	tes,	testes.
cs,	cirrus sac.	tyd,	transverse yolk duct.
ex,	excretory vessel.	up,	uterine pore.
ln,	longitudinal nerve.	ut,	uterus.
mus,	longitudinal muscles.	va,	vagina.
nu,	oötype.	vit,	vitellaria.
od,	oviduct.	vs,	vesicula seminalis.
ov,	ovary.	yd,	yolk duct.
sg,	shell gland.	yr,	yolk reservoir.

Figs. 1–6.—Portions of strobila from scolex to terminal segments. Scale with Figure 1 applies to all.

Figs. 7–9.—Three scoleces showing variation in size and form.

Fig. 10.—Three cross sections, through scolex and neck, showing character of bothria.

Fig. 11.—Ventral view of a young proglottid.

Fig. 12.—Cross section of a proglottid at level of genital papilla.

Fig. 13.—Three eggs from feces of infested dog, on 40th day of culture.

Fig. 14.—Two eggs from the cat material, taken from uterus of alcoholic specimen and contents omitted.

Fig. 15.—Ventral view of a proglottid similar to type shown in Figure 6.

Fig. 16.—Sagittal section through vagina and everted cirrus, of a proglottid similar to Figure 6.

Fig. 17.—Composite drawing of a series of sagittal sections showing relationship of the reproductive organs. Uterus somewhat simplified.

Fig. 18.—Ventral view of the reproductive organs reconstructed from a series of frontal sections. The inner uterine coils, and seminal receptacle seen through the ovary. Uterus correctly figured.

Fig. 19.—Diagram of the oötype complex seen from anterior, reconstructed from a series of cross sections. Ventral surface below.

Fig. 20.—Cross section through the shell gland showing where its cells enter the oötype, and the junction of the yolk duct and oviduct.

IN MEMORIAM

Carlos Chagas (1879–1934)

Carlos Chagas, Director of the Instituto Oswaldo Cruz, died in Rio de Janeiro on November 8, 1934. He was born in Oliveira, Minas Geraes, Brazil, in 1879. In 1903 he graduated from the Faculty of Medicine of the University of Rio de Janeiro. He was appointed director of the committee for the prevention of malaria in Minas Geraes in 1906 and in the same year was made an assistant at the Oswaldo Cruz Institute. In 1917 he became director of this Institute, a position he held until his death.

Dr. Chagas had broad interests. He was general director of the national department of public health from 1920–1926, professor of tropical medicine in the faculty of medicine at the University of Rio de Janeiro, a permanent member of the committee on hygiene of the League of Nations and technical director of the International Institute of Leprosy.

Many honors came to Dr. Chagas, including the Schaudinn Prize (1912), Kummel Prize (1925), the degree of Doctor "Honoris Causa" from the universities of Paris, Brussels and Lima, and Magister Artium "Honoris Causa" from Harvard University. He presented lectures at a number of institutions in this country, including Johns Hopkins University, the University of Chicago, Harvard University, and the Rockefeller Institute. He served as president of the Pan-American Conference on Pathology, Microbiology and Hygiene in Rio de Janeiro in 1929.

The Memoires of the Oswaldo Cruz Institute, Vol. 29, November, 1934, published a list of Dr. Chagas's contributions to scientific literature containing 42 titles. Dr. Chagas discovered a new human trypanosome and the disease produced by it. He devised new methods of prophylaxis and organized a set of sanitary laws covering services relating to rural hygiene, child hygiene and venereal diseases. He organized the work of the International Institute of Leprosy.

Dr. Chagas is probably best known because South American trypanosomiasis is named after him. This is an honor he certainly deserved. The discovery of Chagas Disease was unique since the etiological agent was found before the disease was recognized. Chagas found in the intestine of bugs of the genus *Triatoma* the crithidial stage of a flagellate. He believed these crithidiae to be a phase in the life cycle of a trypanosome. Infected bugs were allowed to feed on marmosets of the genus *Callitrix* which twenty days later were found to have trypanosomes in their blood. He named these trypanosomes *Trypanosoma cruzi* in honor

of Oswaldo Cruz. Finding in the region where the infected bugs were obtained human beings with clinical pictures that fitted no known disease, he suspected the trypanosomes to be the etiological agent. A three-year-old child was observed with trypanosomes in the blood corresponding in morphology to *T. cruzi.* Tissue studies revealed stages in the life history of this species that differed from those previously described for trypanosomes. Leishmania-like bodies were observed within the cells of the myocardium and central nervous system. The cardiac and nervous symptoms characteristic of the disease were thus accounted for. Later the parasites were discovered in the thyroid and other endocrine glands. It seemed probable that some wild animal served as a reservoir for the trypanosomes, and a survey indicated that the armadillo, *Tatusia novemcincta,* acted in this capacity. Thus was completed one of the most interesting series of discoveries involved in the elucidation of any tropical disease—a series of discoveries that made the name Chagas known to everyone in the world interested in medical zoology. No more fitting monument could be desired by any man.

RESEARCH NOTES

OBSERVATIONS ON BRAZILIAN "BLISTER BEETLES."

The species of the genera *Epicauda* (Cantharidae) and *Paederus* (Staphylinidae) are well known as vesicating Coleoptera. These beetles are rather frequent in Brazil, where the people discriminate between the "potó-pimenta" ("pepper-beetle") or "tucura" (*Epicauda*) and the "fôgo-selvagem" ("forest fire") or "trepa-moleque" (*paederus*). The latter, often called simply "potó" or "podó," are generally considered to be the more annoying of the two. Of the species of *Paederus, P. amazonicus* and *P. goeldi* have been found in the state of Amazonas, while *P. columbianus* (see Da Silva— Arch. de Parasit., 15: 425, 1912), *P. rutilicornis* (see Torres—Ann. do prim. Congr. de Dermat. e Sif. Montevideo, 1922) and *P. brasiliensis* occur in the state of Bahia. Most of my material has been identified as belonging to the latter species by Mr. J. F. Zikán, of the Biologic Station of Itatiaya, Brazil, but I received recently, from the state of Parahyba (Brasil) two lots of *Paederus* belonging to a different species (not yet classified), which seems to be allied to *P. fuscipes* Curtis. Their blistering action is the same I was able to state regarding to *P. brasiliensis*.

Study of three lots of *Paederus*, received from three different places in the state of Bahia, has led to the following conclusions.

1. *Paederus* is most abundant during spring and early summer and annoys man mainly when the air is humid (after heavy rains). A medical friend reports that last summer, at his farm in Santo Amaro, Bahia, he awoke one morning almost unable to open his eyes, because of swollen and painful lesions on the eyelids, due to "potós" which had entered the room during the night. Every person in the house had similar lesions on the exposed portions of the body (face, neck and hands).

2. Experimental observations (see Froes, Jl. dos Clinicos, no. 4, Feb. 28, 1934, and Arch. Ital. di Sci. Med. Col. N. F., Jul. 1, 1934) show that the emission of the blistering fluid is not voluntary, but that it exudes when the insect is pressed or crushed, rubbing causing a linear lesion, while crushing produces one in the form of a patch. It is interesting to note that farmers are said to avoid the vesicating action of the "potós" by blowing off the beetles which come in contact with their skin.

3. The vesicating fluid is contained in all parts of the body of the beetles and lesions can be produced experimentally by the isolated head, thorax, abdomen or leg.

4. There is no special mechanism by which the fluid is expelled. When beetles are put under pressure it exudes from any break in the integument.

5. Irritation and vesication may be produced even in the absence of any abrasion of the horny layer of the epidermis, as I was able to cause it by deposing one or two drops of an emulsion of these beetles on the intact skin of the arm or neck of some volunteers, including myself.

The author will greatly appreciate the receipt from doctors in the tropics of any material or information bearing on this subject.—Heitor P. Froes, *Professor of Tropical Medicine, Garcia, 75, Bahia, Brazil.*

A METHOD OF DEMONSTRATING CYSTICERCOIDS OF *HYMENOLEPIS FRATERNA* (*H. NANA* VAR. *FRATERNA STILES*) IN THE INTESTINAL VILLI OF MICE

While working on the larval phase of the dwarf tapeworm a more rapid method than by sectioning was developed for determining the number of cysticercoids in the villi of mice. For infecting purposes it is necessary to obtain eggs

from mice harboring the tapeworms. Four or five mice placed on a screen for 24 hours will pass enough eggs for one experiment. The pellets may be collected on moist paper towels. During feeding hours the mice should be taken off the screen to avoid food being scattered on the feces. After the pellets are collected, emulsify them in water and place in 50 cc. centrifuge tubes. Centrifuge repeatedly aspirating the supernatent fluid each time until it is clear. To float the eggs, add concentrated salt solution to the sediment and centrifuge. The eggs may be collected directly from the surface of this solution. To get the majority of the eggs restir the sediment and centrifuge for 2 or 3 times. The eggs are then diluted with tap water, centrifuged until they are concentrated in 10 or 12 cc. of water which may be placed into a 15 cc. centrifuge tube. With a long pipette the solution is made homogeneous and 0.075 cc. is drawn with a Stoll pipette to determine the total number of eggs in the solution by using the Stoll Dilution Method. The desired egg doses may be placed in short pointed centrifuge tubes.

A half or 1 cc. syringe connected to a slightly curved 18 guage hypodermic needle with a blunt end is used for infecting. After anesthetizing the mice with ether, the syringe needle is introduced directly into the stomach by way of the esophagus and the contents injected. Use 0.2 to 0.4 cc. of fluid per mouse. Best results are obtained by using 2 to 3 month-old mice. The mice should be killed 96 hours after infection, the first half of the small intestine removed, slit open, and allowed to remain in water in the ice-box for over night; this loosens the mucous which may be removed by shaking the intestine in water. The cysticercoids in the villi are then visible and may be studied with the aid of a microscope. For quantitative work all of the small intestine must be removed since a small percentage of the cysticercoids are found in the posterior half. The intestine is cut into convenient lengths and placed in a petri dish and enough water is added to just cover the villi. Too much water causes the edges of the intestine to coil thus hindering the clearness of vision. A quantitative count may then be made with the aid of a medium power of a dissecting microscope. For permanent toto mounts stain the intestine containing the larvae and dehydrate. After the 85 per cent alcohol, place intestine flat in a petri dish and add just enough 95 per cent alcohol to cover. Then draw off the 95 per cent alcohol and add same amount of 100 per cent alcohol. When the tissues are sufficiently hardened to prevent the edges from coiling, add more 100 per cent and clear and mount. If sectioned material is desired, infect mice with very heavy egg doses (10,000 or 20,000 each) and after 96 hours fix parts of the first third of the small intestine, where the concentration of cysticercoids is the greatest. The heaviest infestation is between the first 10 and 20 cms. To save time in sectioning cut that part of the intestine which contains the largest number of cysticercoids into pieces 15 mm. in length and place a number in one paraffin block, so that several intestinal sections can be included in one cut of the microtome knife. All the mice to be infected should be free of adults of the same species of worm in order to get the best results.—A. V. Hunninen, *Department of Helminthology, School of Hygiene and Public Health, The Johns Hopkins University, Baltimore, Md.*

THE OCCURRENCE OF A *TREPOMONAS* SP. IN THE CAECUM OF TURTLES

Three different species of turtles, viz., *Terrapene major, Kinosternon hippocrepis* (Louisiana mud turtle) and *Chelydra serpentina* (common snapper) have recently been examined in this laboratory for intestinal flagellates. In addition to other protozoa, such as *Trichomonas, Hexamita* and an *Entamoeba,* they were found to harbor an organism of the genus *Trepomonas.* As a rule the infection was scanty and could be detected only by the cultural method, although one turtle (*T. major*) showed a good number of the flagellates in a direct smear of the caecal contents.

The genus *Trepomonas* was established by Dujardin (*Histoire naturelle des Zoophytes. Infusoires.* Paris, 294, 1841) for a flagellate which he found in sea-water infusion and named *T. agilis.* Wenyon & Broughton—Alcock (*Trans. Royal Soc. Trop. Med. Hyg.,* 18: 9, 1924) reported a similar organism as a coprozoic form in the stool of a human being suffering from mucous colitis. Alexeieff (*Arch. Zool. Exp.,* VI, N. & R., 1, 1910) recorded the presence of a form with only two long flagella in the rectum of a marine fish, *Box salpa.* It is quite probable that the short flagella which lie in the grooves and are difficult to demonstrate, were overlooked by this observer.

FIG. 1. Outline drawing of *Trepomonas* sp. from the caecum of the turtle, showing the semilunar structure at the anterior end and a group of four flagella on either side, one long and three short. X 3500.

The morphological characters of the organism (Fig. 1) correspond in all essential points with the description given by Wenyon (*Protozoology,* 712, 1926). Around the anterior end of the body there is a semilunar structure which shows a well-defined cleavage at the middle of the convex border. In iron-haematoxylin preparations two or more granules can sometimes be made out in the semilunar body. The lateral aspect of the flagellate reveals a groove on each side. In some individuals the grooves are wide open, producing the appearance of two lateral lobes at the posterior region of the body.

From the point where the semilunar body ends posteriorly four flagella arise on each side. One is a long prominent flagellum directed outwards. The three short flagella which lie in the groove are often difficult to distinguish. During locomotion the flagellate appears to have the posterior part of the body twisted in a peculiar way. It can be readily cultivated on the haemoglobin-saline medium of Row (*Trans. Grant College Med. Soc.,* 1914). Unlike most free-living protozoa it grows at the bottom of this medium. No evidence of cyst formation has been noticed during the period of observation which extended over two weeks. —B. M. DAS GUPTA, *Department of Protozoology, Johns Hopkins University School of Hygiene and Public Health.*

A NOTE ON THE COCCIDIA OF THE MINK

In June, 1934, the name *Eimeria mustelae* was proposed for a newly described species of Coccidium from the mink, *Mustela vison* (see Kingscote, Jour. Parasit., 20: 252–253, 1934). Whilst pending publication the proposed name became preoccupied by that of *Eimeria mustelae* Iwanoff-Gobzem, 1934 (Deutsche Turärzt, Wochenschrift, Mar., 1934, pp. 149–151). As the two Coccidia appear to be distinct species the new name, *Eimeria vison,* is proposed as a substitute for the above homonym.

The writer wishes to express his thanks to Dr. M. C. Hall, of the Zoological Division of the U. S. Bureau of Animal Industry, for his kindly assistance.—
A. A. KINGSCOTE, *Ontario Veterinary College.*

A STUDY OF INTESTINAL PARASITISM IN NEW YORK CITY

In the early part of 1933 a study was begun to ascertain the incidence of intestinal parasitism among patients admitted to the wards of the Third (New York University) Medical Division of Bellevue Hospital.

For the purposes of the study the patients were divided into three groups, as follows:

Group I (Tropical Group). Persons who had lived in or visited any of the so-called tropical countries for any considerable period of time.

Group II (Diarrheal Group). Local residents entering the hospital suffering with a diarrhea which had no very obvious cause.

Group III (Control Group). Local residents of the metropolitan area who had never been in any of the countries which we considered tropical, and who did not have diarrhea.

Results. During the first ten months of the study 319 patients were included in the survey. One thousand stools were examined, the number of examinations per patient varying from 1 to 17, with an average of 3.1. Of the entire group 71.29 per cent had three stool examinations or less. The results of the entire series are given in the table. The percentage distribution of the various types of

TABLE 1.—*Incidence of intestinal parasitism among patients admitted to the wards of the Third (New York University) Medical Division of Bellevue Hospital*

	Group I (Tropical)	Group II (Diarrheal)	Group III controls—(Local residents)	Total
Number of patients	41	86	192	319
Number of stool examinations	124	335	541	1,000
Positives for parasites—pathogenic and non-pathogenic	7 (17%)	27 (31.4%)	33 (17.1%)	67 (21%)
Type of Parasite				
E. coli	3	20	18	41
E. histolytica	4	3	1	8
E. nana	3	5	7	15
I. butschlii			1	1
C. mesnili			2	2
G. intestinalis	2	2	3	7
T. saginata		1		1
E. nana			1	1
A. lumbricoides	1		1	2
N. americanus	1			1
S. stercoralis	1			1
T. dispar	1		1	2

N. B. In a number of patients multiple infestations were encountered.

parasites is not given since the number of positives is small. In the case of *E. histolytica,* 4 positives (cysts or trophozoites) were found in the "tropical" group, which would be 9.7 per cent. Corrected for 6 examinations the figure would be 12.9 per cent. In contrast with this relatively high incidence of amoebiasis in the "tropical" group is the rarity of ameobiasis in the local residents (Groups II and III). Whereas there were four cases of amoebiasis among the 41 patients of the "tropical" group, there were only four cases among the 278 patients of the other two groups (1.43 per cent).—JEAN A. CURRAN, M.D. *Assistant Attending Physician, The Brooklyn Hospital;* JOSEPH E. CONNERY, M.D. *Visiting Physician, Third (New York University) Medical Division, Bellevue Hospital, and* LEONARD J. GOLDWATER, M.D., *Clinical Assistant Visiting Physician, Third (New York University) Medical Division, Bellevue Hospital.*

GIARDIA INFECTIONS IN A NEMATODE FROM CATTLE

While examining some strongyloid nematodes, tentatively identified as *Cooperia oncophora* (Railliet, 1898), from a young bull (8½ months old) born in March, 1934, and reared on the grounds of the Institute, flagellates of the genus *Giardia* were observed in the intestine of several of the nematodes. Of 21 female worms examined six were found infected, all of eight male specimens being

negative. The flagellate infestations were light. In two of the worms only 12 to 15 were seen while 100 or more were present in each of the remaining worms. The *Giardia* were most numerous in the dilated portion of the intestine just anterior to the anus. In several worms, they extended almost to the oesophagus. Some were swimming about, others were attached by their sucking discs to the gut cells. The movement of the flagella was readily noted under high power as the body tissue of the worms was almost transparent. When seen nine hours after the host had been slaughtered, the flagellates in worms kept in physiological saline at room temperature were as active as when first observed. Eleven hours later, movement could no longer be detected although the worms were still alive. No *Giardia* were seen in the mucus from the intestine of the bull in which the worms were embedded although a search was made for them. With the worms in Syracuse dishes in normal saline, none of the flagellates could be observed to escape from the intestine.

This observation appears to constitute the second record of *Giardia* as a parasite of nematodes. Thomson (1925) reported on a case in which two South American rodents (*Viscacia viscacia*) were parasitized with hundreds of bursate nematodes, *Viannella viscaciae* Goodey, 1925. Every worm examined was heavily infected although no flagellates or cyts were found in the intestines of the viscacha. The present case presents a very similar aspect although the incidence and degree of infection is much smaller. Presumably, Thomson found infected male worms. If such is the case, his observation differs from the present one although the absence of infected male worms may be of minor importance. On the other hand, the accumulation of *Giardia* in the posterior portion of the intestines of the female worms in my material was so striking as to suggest the possibility of this being an especially favorable abode, either spatially or physiologically, for them. Thomson does not mention any such localization in his material.

References to protozoa infesting parasitic nematodes are few in number. In addition to the one above, Theiler and Farber (1932) reported *Trichomonas muris* in the chyle-intestine of *Aspicularis tetraptera* and *Syphacia obvelata*, parasitic in white mice; and Becker (1933) reported two motile specimens of *T. muris* in an egg of *S. obvelata*. In the same category with the latter observation should be mentioned the demonstration by Graybill and Smith (1920) that *Histomonas meleagridis* (Smith, 1895) was transmitted by embryonated eggs of *Heterakis gallinae*; the parasite, however, was not seen and appears not to have been seen up to the present time although their experimental work has been confirmed by others.—GEORGE L. GRAHAM, *The Rockefeller Institute for Medical Research, Princeton, N. J.*

EIMERIA FRANKLINII AND *EIMERIA EUBECKERI*, TWO NEW SPECIES OF COCCIDIA FROM THE FRANKLIN GROUND SQUIRREL, *CITELLUS FRANKLINII* SABINE[1]

Examination of fecal smears from a Franklin ground squirrel collected near Ames, Iowa, during August, 1934, revealed the presence of two previously undescribed species of Coccidia belonging to the genus *Eimeria*. The squirrel was killed for the purpose of collecting hexapod ectoparasites and was not examined internally until a lapse of almost twenty-four hours after death, during which time the animal was kept in an electric refrigeration machine at a temperature of approximately 45° F. At the end of this period the intestinal and caecal content was removed for examination and mixed with a four per cent potassium dichromate solution in order that the sporulation process might continue unchecked by bacterial action. The sporulation times recorded are figured from the time the oocysts were placed at room temperature.

[1] Determined by Prof. J. E. Guthrie, Dept. of Zoology, Iowa State College, Ames, Iowa.

Eimeria franklinii n. sp.

Oocysts of *E. franklinii* in the content of small intestine, caecum, and large intestine. Length and width range from 18.6 μ to 24.0 μ and from 13.2 μ to 18.0 μ, respectively; average dimensions being 20.6 μ by 15.2 μ. Oocysts subspherical to ellipsoidal in shape with smooth transparent double cyst wall, just inside of which cytoplasm has a distinct pinkish color. No visible micropyle. After from forty-eight to sixty hours in potassium dichromate, cytoplasmic mass within cyst wall segregated into four sporocysts leaving an oocystic residual body which decreased in size with age. Sporocysts quite regularly ellipsoidal in shape with a protruding nipple on one end (fig. 1), measuring approximately 6 μ by 11.5 μ. Some of sporocysts, however, approached a subovoidal shape. Eighty-four to ninety-six hours in most cases sufficient time for complete sporulation, which resulted in formation of two sporozoites and a distinct sporocystic residual body in each sporocyst. At completion of the sporulation process, two polar inclusions quite distinct.

Eimeria eubeckeri n. sp.

Oocysts of *E. eubeckeri* limited to caecum and large intestine of host examined. Oocysts very different from those of *Eimeria franklinii*. Varied in

1

2

Explanation of Text Figures

Fig. 1. Sporulated oocyst of *Eimeria franklinii* n. sp.

Fig. 2. Sporulated oocyst of *Eimeria eubeckeri* n. sp. (Drawn to same scale, x 2000.)

length from 27.6 μ to 40.2 μ and in width from 21.0 μ to 32.4 μ. Average size 33.7 μ x 23.8 μ. Oocysts distinctly ovoidal in shape with comparatively thick wall. Outer layer of wall brown in color and, except in region of pronounced micropyle, very rough. Inner layer of wall smooth with characteristic pinkish color.

Sporulation was a much longer process in *E. eubeckeri* than in *E. franklinii*. In the former, ten or eleven days were required before sporozoite formation was complete, whereas in *E. franklinii* this process required only three or four days. About the seventh or eighth day sporocysts were formed leaving neither an apparent oocystic residual body nor distinct polar inclusions. The sporocysts were subovoidal in shape with a distinct tapering at one end. Formation of sporozoites left a large mass of sporocysts residual material (fig. 2). Throughout the sporulation process there was a tendency for the content of the oocyst to be nearer the larger end of the oocyst.—Phoebe R. Hall and Edward F. Knipling, *Department of Zoology, Iowa State College.*

THE BLOOD PICTURE IN ACUTE FATAL INFESTATIONS WITH *ANCYLOSTOMA CANINUM*

In a recent publication, Foster and Landsberg (Amer. Jour. Hyg., 20, 1934) have demonstrated that the anemia associated with chronic infestations of *A. caninum* is typically "microcytic hypochromic." Since this blood picture is found clinically with chronic hemorrhage, the conclusion was drawn that the anemia of hookworm disease is due to blood loss. The present work is offered to substantiate the previous studies and to contrast the blood findings of chronic hookworm disease in dogs with those of fatal hookworm infestation. The helminthological and hematological technique used have been fully described in the previous article. Although erythrocyte and leukocyte changes were carefully observed, this report is concerned only with the red cell picture.

Three mongrel puppies, litter mates, two months old, were given lethal doses of the larvae of *A. caninum*. These experimental animals were infected orally by means of viable larvae in gelatin capsules. Changes in the blood picture were observed throughout the course of infection.

In the blood examinations before infection and in those up to seven days after infection when the anemia began to develop, some normal variation was evident. This was particularly true of the erythrocyte count and the hemoglobin values. The two low erythrocyte counts of D 878, occurring ten and thirteen days before infection (Table 1), may be attributed to the anemia found in young puppies which, however, usually occurs at an earlier age.

TABLE 1.—*Showing changes in the red cell picture during course of infection of three dogs (litter mates) with A. caninum.*

Days on experiment	D 876			D 877			D 878		
	R.B.C.	Hb. (gm.)	C.V.	R.B.C.	Hb. (gm.)	C.V.	R.B.C.	Hb. (gm.)	C.V.
1	5.01	8.4	74	5.12	7.4	78	4.09	6.4	61
3	5.04	7.6	75	4.91	8.0	78	4.51	6.9	69
13	5.00	8.7	77	5.29	9.9	69	5.69	8.9	69
13		Infected			Infected			Infected	
17	4.77	6.7	63	4.78	6.7	63	4.62	6.7	63
20	4.95	6.7	69	4.89	7.6	74	5.09	7.3	75
24	3.03	4.5	67	3.87	5.5	75	4.46	6.4	67
27	1.93	2.7	68	3.06	4.3	65	3.97	5.0	72
29	1.61	2.1	62*					4.6	
30				2.16	2.2	65*	2.99	4.3	65*

R.B.C.=the number of red blood cells per cmm blood expressed in decimals of a million (5.01=5,010,000).
Hb.=grams of hemoglobin per 100 cc blood.
C.V.=the mean corpuscular volume in cubic microns.
* Blood sample obtained from heart immediately following death.

The number of red blood cells (R. B. C.) per cmm. progressively decreased after the seventh day of the infection. In no instance during this period was the number of erythrocytes equal to, or above, those of the preceding determinations. The stained blood smears, in all animals, revealed anisocytosis (both microcytes and macrocytes), slight poikilocytosis, and achromia. Nucleated erythrocytes were also found. The hemoglobin values in a general way paralleled the erythrocyte count in that there was a progressive reduction in the amount of hemoglobin present from seven days after the infection up to the death of the

animals. The mean corpuscular volume (obtained by dividing the volume of packed red cells by the erythrocyte count) did not change materially during the course of infection, the slight decrease noted being only a little lower than the normal minimum.

The three infected puppies died within seventeen days after infection. At autopsy there were 432 worms recovered from D 876, 333 worms from D 877, and 251 from D 878. These worms were of all sizes, ranging from small immature forms to large sexually mature ones. The mucous membranes of these animals, which normally have a pink, healthy appearance, were perfectly white at autopsy.

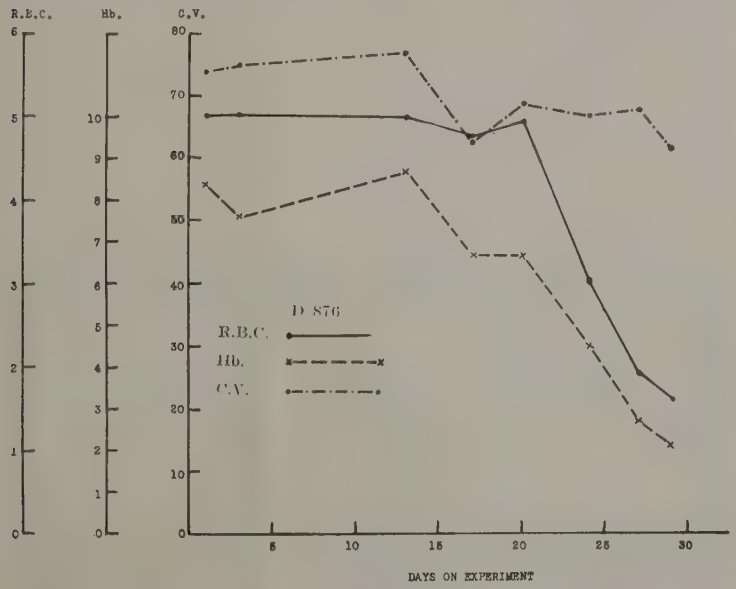

FIG. 1. The course of the blood changes in a young dog (D 876) with acute fatal hookworm infestation (see Table 1).

In none of the infected animals was there a definite hematopoietic response as evidenced by an increase in erythrocytes or hemoglobin. The presence of nucleated red cells in the smears was indicative of an attempt of the hematopoietic system to compensate for the blood loss, but such an attempt was not reflected by the red cells or hemoglobin. From the number of immature worms found at autopsy, along with the progressive decrease in red blood cells and hemoglobin, one may conclude that as the worms matured and their blood sucking activity increased, the response of the hematopoietic centers could no longer keep pace with the bleeding. The result was an acute post-hemorrhagic anemia with a blood loss so great that death was inevitable.

Although there was a very slight reduction of corpuscular volume in the acute fatal hookworm anemia of the three experimental animals, this reduction was in no way comparable to that produced by chronic hookworm anemia as shown in the previous studies and corresponded to the records of the corpuscular volume as found in cases of fatal hemorrhage.

The present study adds to the evidence presented in the previous publication (Foster and Landsberg, *loc. cit.*) that the anemia of hookworm disease, whether

chronic or acutely fatal, is produced by blood loss. It shows also the changes in the blood picture when the loss of blood is so rapid that the hematopoietic system cannot keep pace with the constant drain and death results.—J. W. LANDSBERG AND S. X. CROSS, *Department of Helminthology, School of Hygiene and Public Health, Johns Hopkins University, Baltimore, Maryland.*

AN OBSERVATION ON *GIARDIA*

Giardia is usually described as a symmetric animal. The only parts, generally not showing a symmetric arrangement are the so-called parabasal bodies, the siderophilous structures situated posteriorly of the sucking disk and dorsally of the axostyl.

In films with numerous *Giardia* prepared from the contents of the small intestine of a freshly killed white mouse, all the animals showed another asymetric feature. In all the specimens that showed the flagella distinctly (in the thin parts of the films the majority) one of the posterior flagella was far shorter than the other one. In all of them the free part of the shorter flagellum was a mere stump, like a fox-terrier's tail. The parasites in the films were very numerous, but in spite of hours' searching, not a single *Giardia* with two well developed posterior flagella could be found (Fig. 1, a, b, c).

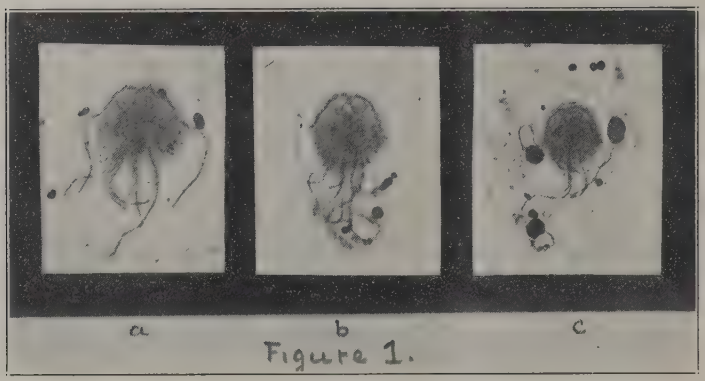

Figure 1.

The films were prepared from scrapings of the intestinal wall emulsified in small drops of blood serum, subsequently they were wet fixed with osmic acid (Wenyon, 1926), then dried, fixed in alcohol and stained with Giemsa's fluid, and finally slightly differentiated in neutral alcohol. Orthodox cytologists may unconditionally condemn dry fixation—often it shows the flagella as well as, if not better, than Heidenhain staining after wet fixation.

In the literature I could find only one figure showing the posterior flagella of *Giardia* unequally long. It is to be found on p. 83 of Sluyter, Swellengrebel and Ihle (De dierlijke parasieten van den mensch en van onze huidieren. Amsterdam, 1921).

Possibly we have to do here with the utmost stage of protoplasmatic division. According to Kofoid and Christiansen (On binary and multiple fission in *Giardia muris* (Grassi). Univ. of Calif. Publ. in Zoology, XVI, 30, 1915) "after the division of the single axostyle to form two, one flagellum and one basal granule go with each daughter axostyle and later in the metaphase the new flagellum grows out. . . ." Our observation does not tally with Kofoid and Christiansen's figures in so far that in the latter both the posterior flagella of the

daughter individuals are already quite long before the protoplasmic fission is completed. A curious feature is that all the specimens show almost exactly the same stage. Either this stage must last very long or divisions of all the parasites of the host must have occurred simultaneously.—S. L. Brug, *Zoological Department of the Instituut voor Tropische Hygiene, Amsterdam.*

THE ORIGIN OF THE GENUS *DIPLOGONOPORUS* LÖNNBERG, 1892

Many malformations occur among tapeworms; scoleces may have a greater or lesser number of hooks and of suckers; strobilae may consist of two chains of segments fused at right angles; they may be bifurcated or even form an "H." Segments may be perforated and the junction between succeeding segments may be narrower than usual. Individual segments may be shortened, not separated, or incompletely separated from other segments. Marginal pores may not exist; there may be two in some segments instead of one. There may be a more or less extensive derangement or multiplication of sexual parts or all sexual organs may be doubled, the latter may even occur reversed in position (Palais, 1933, Ann. Fac. Sc. Marseille, 2d ser., 6: 109–163). During the course of the Broad Tapeworm Investigations I observed the following abnormalities: bifurcated strobila, perforated segments, incompletely separated segments, narrow connections between succeeding segments, partial segments, elongated segments with correspondingly increased reproductive organs and double sets of reproductive organs in one segment.

The latter variation is of unusual interest. In several families and genera of Cestoda double sets of reproductive organs (Fuhrmann, 1925. Rev. Suisse de Zool., 32: 95–97) are the normal condition. Among the Diphyllobothriidae the genus *Diplogonoporus* is characterized by the presence in each segment of a median field, two uterine fields and two lateral fields. Genital pores occur in a longitudinal row in the uterine field, vitelline follicles and testes in lateral and median fields, the former between inner and outer longitudinal muscles and the segments are broader than long (Meggitt, 1924, The Cestodes of Mammals).

The genus *Diplogonoporus* has never been reported from this continent and contains only three valid species (Baer, 1932, Rev. Suisse de Zool., 39: 195–228) occurring in Cetaceans, Pinnepedes and man. Apparently it has made its debut comparatively recently. While Fuhrmann (1925) speculates concerning the origin of tapeworm species with double sets of reproductive organs from those with single sets, he points out that in *Diphyllobothrium latum* the rather frequent doubling is due to the simple intercalations of half segments, an anomaly which he says could not lead to a form with double sets of sexual organs. I have often encountered this variation; the fused segments are always irregular; the two sets of reproductive organs are not of the same size and one is always partially in advance of the other. This condition in immature and gravid segments is illustrated in figs. 1 and 2.

In my search for the plerocercoids of *Diphyllobothrium latum* in North American fresh-water fish, I raised plerocercoids to the adult form for their positive identification. Imagine my surprise when such an experimentally raised worm on first examination seemed to belong to the genus *Diplogonoporus*. Further investigation proved that several of the immature anterior segments of the worm had single reproductive primordia, so that the worm must belong to the genus *Diphyllobothrium*. The doubling in this worm is due to the splitting of the reproductive primordia, complete in most segments, but only partial in a few. The latter condition is illustrated in fig. 3. This complete splitting results in perfect doubling of the reproductive organs at the same level in each segment (see fig. 4). If this condition is hereditary it must result in a new species of *Diplogonoporus*, independently evolved in central North America. While it is not known that the longitudinal splitting of the reproductive primordia is heredi-

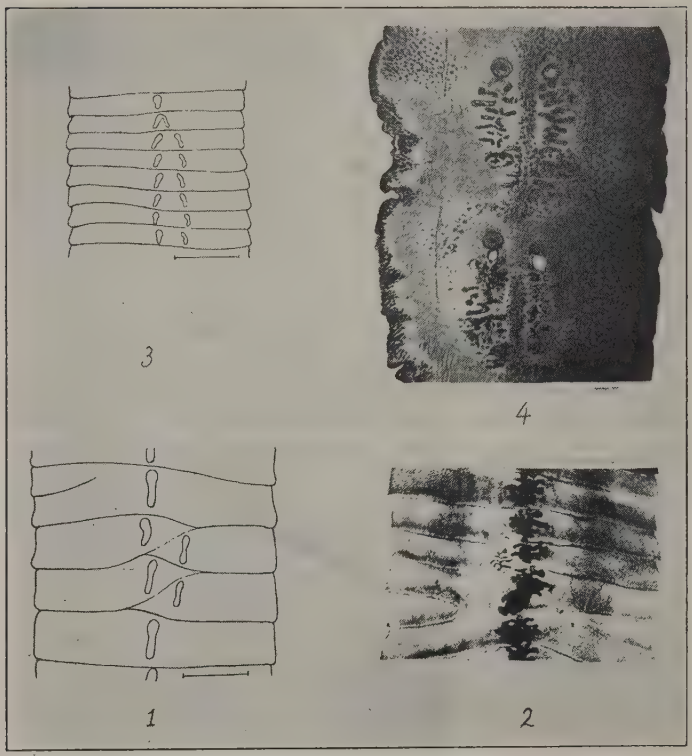

FIG. 1. Tracing of photomicrograph showing how the fusion of half segments causes the doubling of reproductive primordia in the fused segments.

FIG. 2. Photomicrograph, showing unequal doubling in sets of reproductive organs in two mature segments due to lateral fusion of half segments.

FIG. 3. Tracing of photomicrograph showing how double sets of reproductive organs may originate by splitting of the primordia.

FIG. 4. Photomicrograph of frontal section showing mature segments in which the reproductive primordia had split. Note the generic identity with *Diplogonoporus*. Figs. 3 and 4 from the same worm.

tary, the generic identity strongly suggests that from this type of variation the genus *Diplogonoporus* originated and may again originate.

"Discontinuous distribution" may thus be due to independent identical mutations which persist on different continents.

Thus far only one breeding experiment has been performed on tapeworms. It dealt simultaneously with diverse anomalies in *Hymenolepis diminuta*. The same anomalies occurred in the F_1 generation but not in considerable quantity (Palais, 1933). The F_2 generation was not raised.

Genetic research on tapeworms offers several advantages. With species of several families as many as six generations can be raised in one year in easily kept hosts. The environment can be definitely controlled through the nourishment of the hosts. Self-fertilization generally prevents introduction of heterozygous stock. Multiple segments provide much study material of each individual.

This paper is a publication from the Biological Department of Hope College and the Zoological Laboratory of the University of Michigan. It is a by-product of the Broad Tapeworm Investigations sponsored by the Committee on Scientific Investigation of the American Medical Association granted to Dr. George R. La Rue and the late Dr. A. S. Warthin and supported by grants no. 96, 131, and 158.—Teunis Vergeer, *Hope College, Holland, Michigan.*

REVIEWS

AMEBIASIS AND AMEBIC DYSENTERY. By Charles F. Craig, M.D., M.A. (Hon. Yale), F.A.C.S., F.A.C.P., Colonel, United States Army, Retired, D.S.M. Charles C Thomas, Springfield, Ill., and Baltimore, Md. Pp. I–VIII, 1–315, 54 illustrations.

This work constitutes a compilation of information on the recognition, nature, transmission, and control of amebic disease useful alike to the protozoologist, laboratory technician, clinician, and public health officer. It is tremendously enriched by the original observations, experience, and opinions of the author whose familiarity with the subject, based upon extensive laboratory inquiry and clinical practice at home and abroad, is unequalled by anyone else in this country. The book consists of over 300 pages of profusely illustrated text divided into twelve chapters, These deal with the history, geographical distribution, etiology, epidemiology, pathology, symptomatology, diagnosis, prognosis, prophylaxis, and treatment of amebiasis and amebic dysentery. All of these subjects are dealt with adequately but especial emphasis is laid upon pathology, symptomatology, diagnosis (including clinical, microscopic and serological), and treatment.

Col. Craig believes that the prevailing mode of transmission of endemic amebiasis in urban districts is by means of food-handlers (p. 48), that epidemic amebiasis is usually due to fly-borne or water-borne contamination (pp. 47 and 56 *et seq.*), that *Endamoeba histolytica* is essentially a tissue parasite (pp. 28, 35, 71, 80, *et al.*), that "in every carrier of this parasite cytolysis and necrosis of the superficial epithelium in the invaded areas of the intestine is (*sic.*) continually occurring" (p. 80) but, while denying indefinite commensalism (p. 80) he admits "that some of the trophozoites may live and multiply in the bowel lumen for a limited period of time" (p. 28). The author is of the opinion that the extensive researches upon experimental pathology of amebiasis in lower animals is unilluminating and even misleading as far as an understanding of the morbid processes in human amebiasis are concerned. As a corollary to his belief that *E. histolytica* is an obligatory tissue parasite, Col. Craig is convinced that "practically every untreated carrier of this parasite either has, or will have, symptoms of the infection, unless spontaneous recovery occurs" (p. 122) though "the carrier may fail entirely to recognize the presence of symptoms and it is only after treatment has rid him of his infection that he realizes that he did have symptoms and was not enjoying good health" (p. 122). For routine diagnosis, the author feels that the simple smear technique is quite adequate as far as microscopical examination is concerned (p. 201), desirably supplemented, in case no organisms are found, by a direct centrifugation method of concentration for cysts (p. 200), and a suitable culture method for cysts or trophozoites (p. 205). He advocates the complement fixation test, with the development of which his name has been so eminently associated, not as a substitute for microscopical examination of the feces in cases of intestinal infection, but points out that the test has a real value where these examinations cannot be made by qualified microscopists, or in those rare instances of hepatic infection in which the stools appear to be negative, or as a check upon the efficacy of treatment (pp. 245 and 246). For the specific treatment of acute and chronic amebic dysentery, the author advocates subcutaneous injections of not more than a grain of emetine hydrochloride daily until symptoms subside, but for not more than 12 days serially. After symptoms subside, a full course of chiniofon (yatren, anayodin) is given with proper regard for the patient's reaction to it (p. 294).

It is remarkable that so few errors of omission or of commission should have occurred in such an exhaustive piece of writing. A few which have caught the eye of the reviewer are as follows. On p. 33, the author states that "under natural conditions cysts of this parasite have not been observed in either nat-

urally or experimentally infected dogs," whereas the reviewer published in 1932 a short article in the journal of which the author is editor calling attention to the presence of amoebic cysts and trophozoites morphologically undistinguishable from *Endamoeba histolytica* in the stool of a Baltimore dog.

It is confusing to read on p. 35 that Walker and Sellards succeeded in infecting 18 out of 20 human volunteers with *E. histolytica,* and on p. 130 where reference is again made to this celebrated work that these authors succeeded in infecting 17 out of 20 individuals. The disparity is easily resolved by noting that 17 of the 20 men became infected as the result of a *single* feeding of infective material and that the 18th did not become infected until after *repeated* feedings.

The reviewer is at a loss to account for the statements on pp. 193 and 223 that the vegetative form of *Iodamoeba* contains a glycogen mass. Certainly its occurrence must be rare and virtually restricted to the precystic trophozoites to judge by experience in the reviewer's laboratory. This feature is not mentioned as being characteristic of Iodamoeba trophozoites in Dobell and O'Connor's "Intestinal Protozoa of Man," in Wenyon's "Protozoology" nor, indeed, in Col. Craig's "Parasitic Protozoa of Man."

In conclusion, both the author and publisher are to be congratulated on the extraordinarily fine printing, illustration, and content of this book. It will undoubtedly remain the standard text and reference in its field for years to come.—JUSTIN ANDREWS.

VETERINARY HELMINTHOLOGY AND ENTOMOLOGY. The diseases of domesticated animals caused by helminth and arthropod parasites. By H. O. Monnig. xvi. 402. William Wood and Company, Baltimore, Mr.

The existing need for an adequate text of parasitology for students and practitioners of veterinary medicine is largely filled by this volume. The book is divided into four sections: (1) a brief introduction (10 pages); (2) an outline of laboratory techniques, including diagnostic methods and a statement of the procedures in the procuring and handling of arthropods and helminths for taxonomic work or museum use; (3 and 4) the helminth and arthropod parasites of domesticated animals taken up in order of their systematic position. The morphology, life history, pathogenicity, clinical symptoms, treatment, and control are given where known. The protozoa are not included. The more important parasites or more extensively studied forms are treated individually. In other cases the individual parasites are listed and morphology and life history given but disease discussed collectively for a group such as "Taeniasis in dogs and cats." This avoids needless duplication and simplifies the material for the student or practitioner. A brief résumé is also included of some of the more commonly used anthelmintics—such as carbon tetrachloride. Very valuable are the many references given in footnotes, particularly references to the more recent literature. Very valuable also is the host parasite list with page references given in the closing pages of the book. The reviewer, however, was disappointed by the casual treatment of the growing body of literature on the various phases of host resistance or immunity to parasitic infection. Notable too is the complete absence of any reference to Kreis and Faust's report of a parasitic male in the strongyloides though the life history of these forms is discussed briefly.

On the whole the author is to be congratulated on the selection of material and the presenting of it in a readable manner. It is not intended to be a complete handbook of the subject yet it makes a good reference book. Written by a man whose experience has centered in Africa, the text nevertheless covers the subject adequately for other parts of the world. In the opinion of the reviewer the book is a valuable and adequate textbook for the veterinary student or practitioner, and will also make a valuable addition to the library of the professional helminthologist and the specialized student of helminthology and economic or medical entomology.—G. F. OTTO.

SCHISTOSOMIASIS. By Dr. Rameses Girges. John Bale, Sons & Danielson, Ltd., Publishers, London.

Located in the center of a great endemic area, the author rightly emphasizes the importance of the subject and the need for further study. As is stated in the preface, the book is not presented as a complete treatise but includes studies made in private practise during the last decade; it offers a classification convenient clinically which the author believes will aid in diagnosis and treatment. At the outset he acknowledges his indebtedness to previous workers and freedom in the use of their writings evidently warranted in view of the tremendous array of distinguished and able predecessors in the field. The preface closes with acknowledgments to a long series of associates and helpers who have contributed to the present work.

The book is divided into ten parts, the first few general, entitled Historical, Parasitology, Epidemiology and Geographical Distribution, and Practical Study of Schistosomes. Then follow parts on Schistosomiasis Haematobium or Urinaria, Schistosomiasis Mansoni; Intestinal Type, Schistosomiasis Mansoni; Visceral Type, and Schistosomiasis Japonicum, of which the author states he has not seen a single case and has relied entirely on work of previous writers. The closing parts handle Specific Treatment and Prophylaxis. These titles of the parts, which are still further subdivided into 26 chapters, indicate clearly the comprehensive way in which the author has envisaged his subject. They give opportunity for presenting an extensive series of observations made in actual clinical work and also many opinions and conclusions which he himself states concern subjects in which much confusion has prevailed and in the opinion of the reviewer which may still encounter criticism. Evidently this is no place to attempt to discuss moot questions. The author has laid before workers in this field a mass of details. It is by no means easy to distinguish at all points between the material taken from other works and the concrete observations of the author himself. The text fails to carry conviction and one often stops reading to ask himself the basis for categorical statements. This attitude is certainly most evident in connection with the interpretations which the author offers. Much further work must be done before general acceptance will be given to the views advanced in the book.

The book is well printed, the illustrations are numerous and appropriate. However, many figures are vague and sketchy to the point of failure in details on which precise knowledge is sought and fail to meet the standards of the laboratory worker.—HENRY B. WARD.

STUDIES ON SOME PROTOZOAN PARASITES OF FISHES OF ILLINOIS. By Richard Roksabro Kudo. Illnois Biological Monographs. Vol. 13, No. 1, 44 pp., 129 figs. 1934.

In this monograph are presented the results of examinations of 1,300 fish belonging to 13 families and 35 species. The families Catostomidae, Cyprinidae and Siluridae were commonly parasitized by histozoic protozoa. The genera of parasites encountered were Myxobolus, Myxidium, Henneguya, Thelohenellus, Costia, Cyclochaeta and Octomitus. Nineteen new species of Myxosporidia are described by the author who is an authority on this group.—ROBERT HEGNER.

THE PAPILLOSE ALLOCREADIIDAE. By Sewell Hepburn Hopkins. Illinois Biological Monographs, Vol. 13, No. 2, 77 pp., 4 pls., 1934.

This study of papillose Allocraediidae adds another to the large number of important monographs in parasitology that have appeared in the University of Illinois series of Biological Monographs since 1914. The author has considered the systematics, morphology and life history of this trematode group and has added important information on each of these phases of the subject. On the systematic side he has added many details to the original descriptions of a num-

ber of the species which has made it possible to give more adequate specific diagnoses. He has also shown that several species previously considered as separate are synonyms and has given detailed corrected generic diagnoses for *Crepidostomum, Megalogonia,* and *Bunodera.* In addition to the adult structures used in the older diagnoses he has utilized wherever possible as distinguishing characters in both specific and generic diagnoses the pattern of the excretory system, the course of the life cycles, and details of structure of the miracidium, redia, and cercaria. Among the numerous additions to our knowledge of the morphology of the forms considered are detailed descriptions and analyses of the excretory system of four species belonging to three genera. Perhaps the most important part of the monograph is that describing the studies on life histories. For two species, *Crepidostomum cooperi* and *Megalogonia ictaluri,* the life cycles are worked out experimentally and all stages are described in detail. For several other species significant new information on the life cycles is given. Although the author suggests a number of changes in classification he does not attempt a general revision of the family Allocreadiidae. He points out, however, that fundamental differences in the life cycles of species included in this family indicate that further changes will be necessary when more knowledge is available on the structure of the excretory system and the life cycles of the different genera now included in this group.—W. W. Cort.

AMERICAN SOCIETY OF PARASITOLOGISTS

Tenth Annual Meeting, Pittsburgh, Pennsylvania, December 27, 28, and 29, 1934

The American Society of Parasitologists held its tenth annual meeting on Thursday, Friday, and Saturday, under the presidency of Professor E. E. Tyzzer. The program contained 54 titles, and 32 of the reports were presented either orally or by demonstration. The Thursday program consisted of papers on helminthology and protozoology; researches on the morphology, life history, physiology, and control of the parasites concerned. On Friday morning the society met in a joint session with the American Society of Zoologists; the program consisted of six invited papers dealing with various aspects of susceptibility and resistance to infection by animal parasites. Each of the speakers, Justin Andrews, Elery R. Becker, Asa C. Chandler, Ernest C. Faust, Wendell Gingrich, and Oliver R. McCoy, reported results of his own research and their bearing on the problem of immunity to parasitic infections. The discussion after the papers was led by Doctor W. W. Cort. Following the joint program the presidential address was given by Professor Tyzzer, who spoke on "Viewpoints and Orientation in Parasitology." This address was published in the February, 1935, number of the Journal of Parasitology. At noon the society met for the annual luncheon and business meeting. Friday afternoon was reserved for the annual demonstration program, an outstanding feature of the meeting, and one that has received increasing attention in recent years. The demonstrations presented studies on the morphology, developmental cycles, taxonomy and pathology of various Protozoa, flatworms, nematodes and Acanthocephala. The Saturday morning program was devoted to papers of medical importance and diseases caused or transmitted by arthropods. In a special invited paper, Dr. Cornelius B. Philip, Rocky Mountain Laboratory, U. S. Public Health Service, reported on the 1934 epidemic of tick-borne tularemia in Montana sheep.

The twenty-third meeting of the Council was held on Wednesday afternoon, December 26th, at the Hotel Schenley, Pittsburgh

The reports of the secretary and treasurer were received. J. E. Ackert and D. H. Wenrich were appointed as an auditing committee to examine the accounts of officers of the Society for the year 1934. On approval by the auditing committee the reports of the secretary and treasurer were accepted and placd on file.

The secretary reported for N. R. Stoll, custodian of the "Princeton Secretarial Fund" which amounts to $349.03. The report of the custodian was accepted and ordered filed. A vote of thanks was expressed to Doctor Stoll.

Thirteen applicants were elected to membership in the Society.

The Council voted to recommend to the annual meeting the election of Doctor Charles W. Stiles to life membership in the Society.

The Council took up the question of election of members and voted to recommend to the annual meeting that the requirement of payment of dues for two years in advance be discontinued and that applicants be accepted with the advance of one year's dues. The president was instructed to appoint a committee of three to consider the question of eligibility for membership, the number of affirmative votes necessary for election and any other relevant questions. Doctors Riley, Cort, and Stoll were named by the president as members of this committee.

The reports of the editorial committee and the committee on necrology were presented by Doctor Cort. Doctor Cort reported on the question of publication of the abstracts of the papers presented at the 1934 summer meeting of the American Association for the Advancement of Science at Berkeley, Calif., where Professors Kofoid and Herms acted for the Society in a joint program with Section

N of the A. A. A. S. Professor Kofoid had written to the Chairman of the Editorial Committee requesting that the abstracts of the summer meeting be published in the JOURNAL OF PARASITOLOGY. The Chairman of the Committee had referred the matter for action to the annual meeting of the Council. The subject was discussed and finally it was voted to publish the abstracts of the summer meeting held at Berkeley. Doctor Riley raised the question as to whether or not, if a similar meeting were held next summer at Minneapolis, the abstracts should be submitted for publication in the JOURNAL. Council voted to authorize Doctor Riley to act as local representative for the Society in connection with the summer meeting at Minneapolis, 1935, with the understanding that no financial obligations could be incurred against the Society, but that the abstracts of papers presented would be published in the JOURNAL.

Doctor Ackert raised the question as to whether or not, if an author agreed to pay for the publication of a manuscript in the next issue of the JOURNAL, it should be accepted. In the discussion it was brought out that often such urgent publication is requested by a man of means to secure priority for work which he has reason to believe that someone else is submitting for publication. It was regarded as unethical to be a party to such practice and the editorial committee was instructed that papers submitted should take their regular place in the order of receipt. The report of the editorial committee was accepted and placed on file.

Since the mail vote to elect a successor to Doctor Root had failed to give a majority, the question was referred to Council for decision. Professor Riley was unanimously elected to succeed Doctor Root as member for entomology on the Editorial Committee and Doctor Robert Matheson, Professor of Medical and Veterinary Entomology, Cornell University, to succeed Doctor Riley as member of the Editorial Board.

The Council voted a resolution submitted by Doctor Stoll, "That parasitologists everywhere appreciate the assistance and value of the Index Catalogue of Medical and Veterinary Zoology, issued by the Zoological Division of the Bureau of Animal Industry; that the American Society of Parasitologists notes with regret that the publication of the Author Series has been interrupted for about two years, and respectfully requests the responsible officials to take all possible proper steps to expedite the further publication of the catalogue. That the secretary be instructed to send copies of this resolution to the Secretary of Agriculture, the Chief of the Bureau of Aanimal Industry, and to the Chief of the Zoological Division of that Bureau." The Council recommended that this resolution be presented at the annual meeting of the Society.

The report of the committee on Terminology was presented by the secretary. It was accepted and motion passed to refer the report to the annual meeting of the Society with a recommendation that the committee be continued.

The Council voted unanimously on a list of nominees for officers of the Society to be presented to the annual business meeting of the Society.

Following the Council meeting the annual dinner given by the president to Council and former presidents was held at the Hotel Schenley.

The tenth annual business meeting of the Society was held on Friday, December 28th, at the Hotel Schenley, following the annual luncheon of the Society.

The first item of business; reports of officers. The report of the secretary, certified as correct by the auditing committee of Council, was accepted and placed on file.

The report of the treasurer, certified correct by the auditing committee, was accepted and ordered filed.

The report of the representatives of the American Society of Parasitologists on the Council of the American Association for the Advancement of Science was presented by Doctors Becker and La Rue. The report was accepted and ordered filed.

The report of the representatives of the American Society of Parasitologists on the Council of the United Association of Biological Societies was made by Doctor Wenrich and on motion duly approved.

There was no report from the committee on nomenclature, G. Steiner, Chairman.

The report of the committee on terminology, M. Hertig, W. H. Taliaferro, and B. Schwartz, was read by the secretary. The report was accepted and committee continued.

The report of the committee on necrology, W. W. Cort, Chairman, was presented. On motion, duly seconded, the report was adopted and ordered filed.

The report of the Editorial Committee of the JOURNAL OF PARASITOLOGY was presented by W. W. Cort, Chairman. The financial statement, certified as correct by the auditing committee, was accepted and ordered filed.

After the reports of the officers and standing committees the president called for new business. He reported for information of the Society that the Council voted to elect Doctor W. A. Riley successor to Doctor Root as representative of entomology on the editorial committee of the JOURNAL OF PARASITOLOGY. Also that Doctor Robert Matheson, Professor of Medical and Veterinary Entomology, Cornell University, was elected to succeed Doctor Riley as member of the editorial board.

The secretary reported that Council voted to recommend to the annual meeting of the Society the election of Doctor Charles W. Stiles as life member. The motion was seconded and carried unanimously.

The secretary moved also the adoption of the resolution proposed by N. R. Stoll and endorsed by vote of Council. The motion was seconded and carried.

Reporting for Council, secretary moved the adoption of recommendation of Council, as an emergency measure, the present requirement that applicants for membership make a payment of annual dues for two years in advance be discontinued and that new members be elected on the payment of one year's dues. Seconded and carried.

The secretary presented the unanimous recommendation of Council for officers of the Society for the year 1935. For president (1 year), Charles F. Craig, Tulane University; for vice-president (1 year), H. J. Van Cleave, University of Illinois; for secretary (2 years), H. W. Stunkard, New York University; for treasurer (2 years), Justin Andrews, Johns Hopkins University; for Council members at large for four years, J. E. Ackert, Kansas State College, and W. W. Cort, Johns Hopkins University. On motion, duly seconded, Society voted to elect the officers nominated by Council.

The Society voted an expression of thanks to Doctor Stanley T. Brooks, local representative for the Pittsburgh meeting.

On motion the Society voted to adjourn until the eleventh annual meeting to be held at Christmas time, 1935, in St. Louis.

Respectfully submitted,

H. W. STUNKARD, *Secretary.*